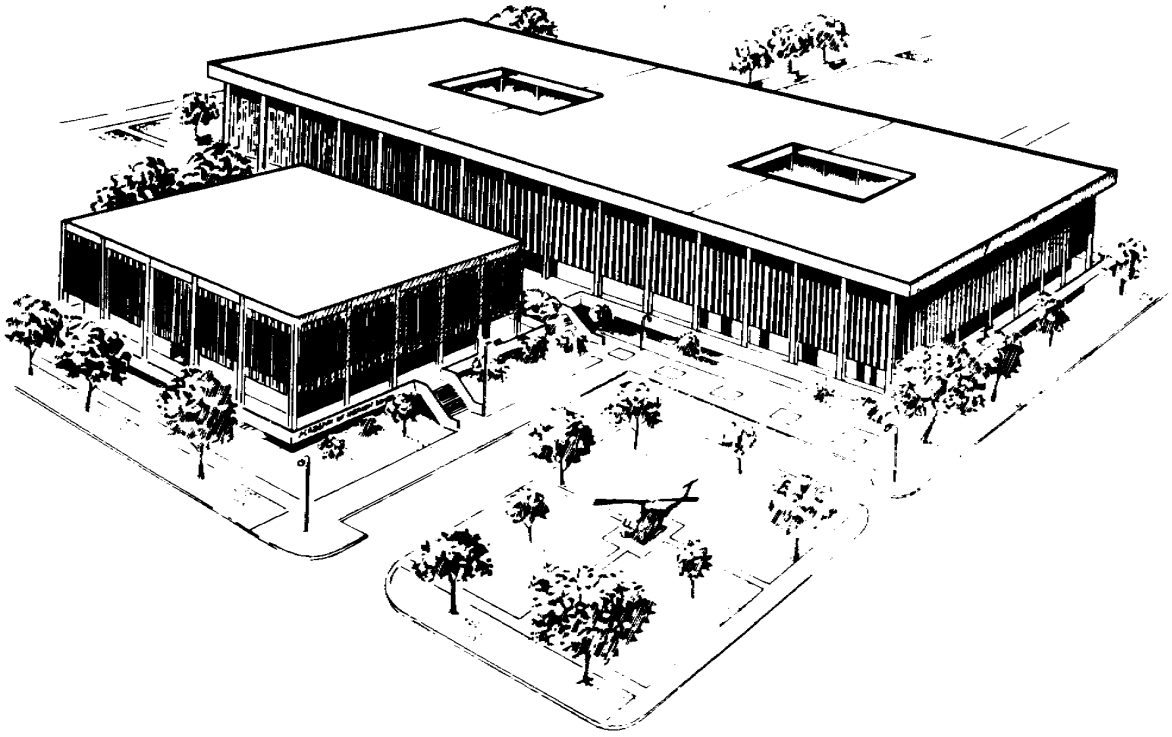
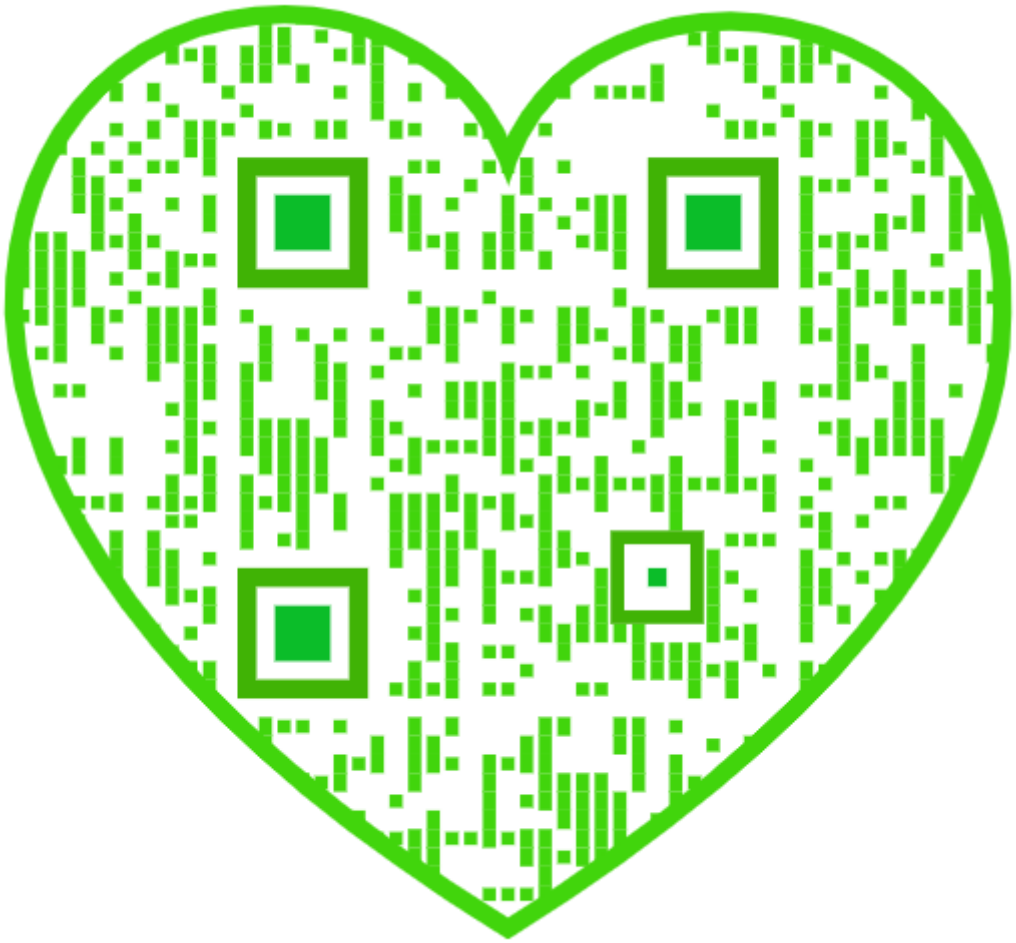
U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
FORT SAM HOUSTON, TEXAS 78234-6100



PHARMACOLOGY IV

SUBCOURSE MD0807 EDITION 100



DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

ADMINISTRATION

Students who desire credit hours for this correspondence subcourse must enroll in the subcourse. Application for enrollment should be made at the Internet website: http://www.atrrs.army.mil. You can access the course catalog in the upper right corner. Enter School Code 555 for medical correspondence courses. Copy down the course number and title. To apply for enrollment, return to the main ATRRS screen and scroll down the right side for ATRRS Channels. Click on SELF DEVELOPMENT to open the application; then follow the on-screen instructions.

For comments or questions regarding enrollment, student records, or examination shipments, contact the Nonresident Instruction Branch at DSN 471-5877, commercial (210) 221-5877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail accp@amedd.army.mil, or write to:

NONRESIDENT INSTRUCTION BRANCH
AMEDDC&S
ATTN: MCCS-HSN
2105 11TH STREET SUITE 4191
FORT SAM HOUSTON TX 78234-5064

Be sure your social security number is on all correspondence sent to the Academy of Health Sciences.

CLARIFICATION OF TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" 'are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

USE OF PROPRIETARY NAMES

The initial letters of the names of some products may be capitalized in this subcourse. Such names are proprietary names, that is, brand names or trademarks. Proprietary names have been used in this subcourse only to make it a more effective learning aid. The use of any name, proprietary or otherwise, should not be interpreted as endorsement, deprecation, or criticism of a product; nor should such use be considered to interpret the validity of proprietary rights in a name, whether it is registered or not.

TABLE OF CONTENTS

Lesson			Paragraphs
	INTRODUCTION		
1	THE HUMAN DIGESTIVE SYSTEM		
	Section I.	Introduction	1-1--1-2
	Section II.	The Supragastric Structures	1-3--1-5
	Section III.	The Stomach	1-6--1-7
	Section IV.	The Small Intestine and Associated Glands	1-8--1-9
	Section V.	The Large Intestines	1-10--1-12
	Section VI.	Associated Protective Structures	1-13--1-14
	Section VII.	Accessory Structures of the Digestive System	1-15--1-16
	Section VIII.	Absorption and Metabolism in the Digestive System	1-17--1-20
	Section IX.	Disorders and Diseases of the Digestive Tract	1-21--1-24
	Exercises		
2	ANTACIDS AND DIGESTANTS		
	Section I.	Antacids	2-1--2-3
	Section II.	Digestants	2-4--2-6
	Exercises		
3	EMITICS, ANTIEMETICS, AND ANTIDIARRHEALS		
	Section I.	Overview	3-1--3-2
	Section II.	Emetics	3-3--3-4
	Section III.	Antiemitics	3-5--3-6
	Section IV.	Antidiarrheals	3-7--3-8
	Exercises		
4	CATHARTICS		
	Section I.	Introduction	4-1--4-6
	Section II.	Cathartic Agentss	4-7--4-10
	Exercises		

Lesson			Paragraphs
5	FLUID AND ELECTROLYTE THERAPY		
	Section I.	Introduction to Fluid and Electrolyte Physiology (Self Paced Text)	Frame 1--81
	Section II.	Precautions and Complications Associated with Intravenous Therapy	5-1--5-5
	Section III.	Categories of Intravenous Fluids and Their Uses	5-6--5-10
	Exercises		
6	REVIEW OF THE ENDOCRINE SYSTEM		
	Section I.	Introduction	6-1--6-3
	Section II.	Endocrine Glands	6-4--6-15
	Section III.	Disorders of the Human Reproductive System	6-16--6-18
	Exercises		
7	THYROID, ANTITHYROID, AND PARATHYROID PREPARATIONS		
	Section I.	Overview	7-1--7-5
	Section II.	Thyroid Preparations	7-6--7-8
	Section III.	Antithyroid Preparations	7-9--7-10
	Section IV.	Parathyroid Preparations	7-11--7-12
	Exercises		
8	REPRODUCTIVE HORMONES AND ORAL CONTRACEPTIVES		
	Section I.	Introduction	8-1--8-2
	Section II.	Uses of Reproductive Hormones	8-3--8-10
	Section III.	Specific Reproductive Hormones	8-11--8-14
	Section IV.	Contraception	8-15--8-20
	Section V.	Ovulation Inducing Agent	8-21--8-22
	Exercises		

Lesson			Paragraphs
9	ADRENOCORTICAL HORMONES		
	Section I.	Overview	9-1--9-6
	Section II.	Glucorticoids and Synthetic Agents	9-7--9-14
	Exercises		
10	INSULIN AND THE ORAL HYPOGLYCEMIC AGENTS		
	Section I.	Physiology of Insulin	10-1--10-6
	Section II.	Conditions Due to Abnormal Amounts of Insulin in the Bloodstream	10-7--10-8
	Section III.	Treatment of Diabetes Mellitis by Insulin Therapy	10-9--10-17
	Section IV.	Oral Hypoglycemic Agents	10-18--10-22
	Exercises		
11	OXYTOCICS AND ERGOT ALKALOIDS		
	Section I.	Oxytocics	11-1--11-8
	Section II.	Ergot Alkaloids	11-9--11-13
	Exercises		

CORRESPONDENCE COURSE OF THE
U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

SUBCOURSE MD0807

PHARMACOLOGY IV

INTRODUCTION

In Subcourses MD0804, MD0805, and MD0806, various topics pertaining to anatomy, physiology, pathology, and pharmacology were presented. Specifically, topics like drug references, the physiology of the nervous system, nervous system drugs, and dermatological agents were introduced.

In this subcourse, MD0807, other systems of the body (for example, the digestive system) and the drugs used to treat conditions of those systems will be discussed. As in the other pharmacology subcourses, you will be provided background material in anatomy, physiology, and pathology in order to help you learn about the specific drugs discussed in the subcourse.

Remember, this subcourse is not intended to be used as an authoritative source of drug information. As you know, new drugs are being discovered and new uses for existing drugs are being found through research. Therefore, this subcourse can serve as a means for your review or initial learning of pharmacological concepts. You are strongly encouraged to use other references (see MD0804, Pharmacology I) to gain additional information which will help you to do your job in a better way. Knowing more about pharmacology can help you to better serve your patients.

Subcourse Components:

This subcourse consists of eleven lessons as follows:

- Lesson 1 The Human Digestive System.
- Lesson 2, Antacids and Digestants.
- Lesson 3, Emetics, Antiemetics, and Antidiarrheals.
- Lesson 4, Cathartics.
- Lesson 5, Fluid and Electrolyte Therapy.
- Lesson 6, Review of the Endocrine System.
- Lesson 7, Thyroid, Antithyroid, and Parathyroid Preparations.
- Lesson 8, Reproductive Hormones and Oral Contraceptives.
- Lesson 9, Adrenocortical Hormones.
- Lesson 10, Insulin and the Oral Hypoglycemic Agents.
- Lesson 11, Oxytocics and Ergot Alkaloids.

Here are some suggestions that may be helpful to you in completing this subcourse:

--Read and study each lesson carefully.

--Complete the subcourse lesson by lesson. After completing each lesson, work the exercises at the end of the lesson, marking your answers in this booklet.

--After completing each set of lesson exercises, compare your answers with those on the solution sheet that follows the exercises. If you have answered an exercise incorrectly, check the reference cited after the answer on the solution sheet to determine why your response was not the correct one.

Credit Awarded:

Upon successful completion of the examination for this subcourse, you will be awarded 14 credit hours.

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Branch at Fort Sam Houston, Texas.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1 The Human Digestive System.

TEXT ASSIGNMENT Paragraph 1-1 through 1-24.

LESSON OBJECTIVES After completing this lesson, you should be able to:

1-1. Given a group of statements, select the statement that best defines the human digestive system.

1-2. From a list of names of organs, select the organ(s) which are part of the human digestive system.

1-3. Given a group of statements, select the statement that best describes the function of a digestive enzyme.

1-4. Given a diagram of the human digestive system and a list of names of organs of the human digestive system, match the name of an organ with its location on the diagram.

1-5. Given the name of a part of the human digestive system and a group of statements, select the statement that best describes that part of the human digestive system.

1-6. Given the name of a part of the human digestive system and a group of statements, select the statement(s) that best describe the function(s) of that part of the digestive system.

1-7. From a group of statements, select the statement that best describes the digestion of fats, carbohydrates, or proteins.

1-8. Given the name of a disease or disorder of the human digestive system and a group of statements, select the statement that best describes that disease or disorder.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

THE HUMAN DIGESTIVE SYSTEM

Section I. INTRODUCTION

1-1. GENERAL

a. **Definition.** The human digestive system is a group of organs designed to take in foods, initially process foods, digest the foods, and eliminate unused materials of food items. It is a hollow tubular system from one end of the body to the other end. See figure 1-1.

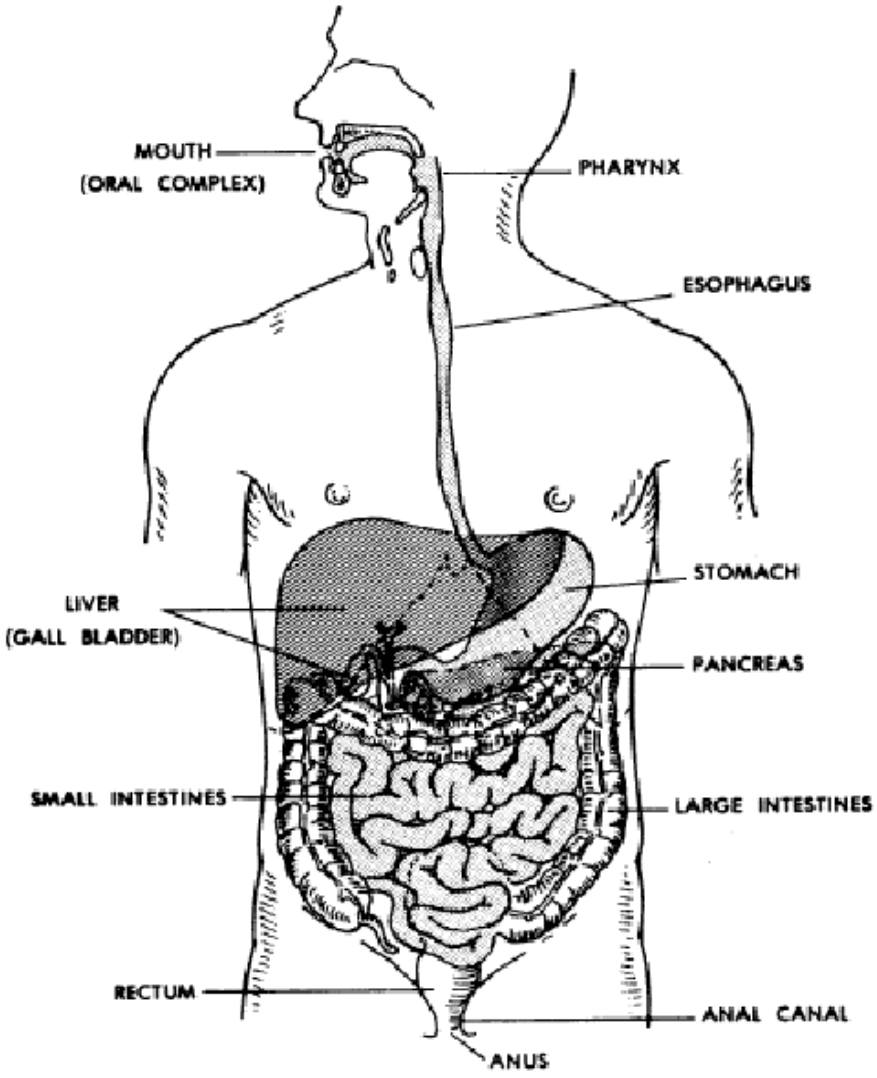


Figure 1-1. The human digestive system.

b. **Major Organs.** The major organs involved in the human digestive system are listed below. They are each discussed later in this lesson.

(1) Mouth or oral complex.

(2) Pharynx.

(3) Esophagus.

(4) Stomach.

(5) Small intestines and associated glands.

(6) Large intestines.

(7) Rectum.

(8) Anal canal and anus.

c. **Digestive Enzymes.** A catalyst is a substance that accelerates (speeds up) a chemical reaction without being permanently changed or consumed itself. A digestive enzyme serves as a catalyst, aiding in digestion. Digestion is a chemical process by which food is converted into simpler substances that can be absorbed or assimilated by the body. Enzymes are manufactured in the salivary glands of the mouth, in the lining of the stomach, in the pancreas, and in the walls of the small intestine.

1-2. FOODS AND FOODSTUFFS

Examples of food items are a piece of bread, a pork chop, and a tomato. Food items contain varying proportions of foodstuffs. Foodstuffs are the classes of chemical compounds that make up food items. The three major types of foodstuffs are carbohydrates, lipids (fats and oils), and proteins. Food items also contain water, minerals, and vitamins.

Section II. THE SUPRAGASTRIC STRUCTURES

1-3. ORAL COMPLEX

The oral complex consists of the structures commonly known together as the mouth. It takes in and initially processes food items. See figure 1-2.

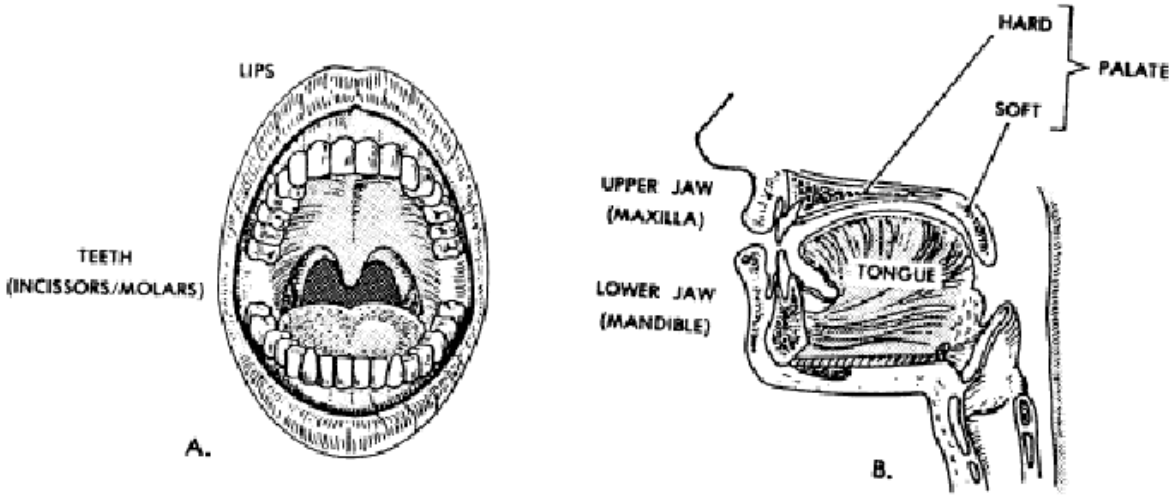


Figure 1-2. Anatomy of the oral complex.

a. **Teeth.**

(1) A tooth (figure 1-3) has two main parts, the crown and the root. The root canal passes up through the central part of the tooth. The root is suspended within a socket (called the alveolus) of one of the jaws of the mouth. The crown extends up above the surface of the jaw. The root and inner part of the crown are made of a substance called dentin. The outer portion of the crown is covered with a substance known as enamel. Enamel is the hardest substance of the human body. The nerves and blood vessels of the tooth pass up into the root canal from the jaw substance.

(2) There are two kinds of teeth, anterior and posterior. The anterior teeth are also known as incisors and canine teeth. The anterior teeth serve as choppers. They chop off mouth-size bites of food items. The posterior teeth are called molars. They are grinders. They increase the surface area of food materials by breaking them into smaller and smaller particles.

(3) Humans have two sets of teeth, deciduous and permanent. Initially, the deciduous set includes 20 baby teeth. These are eventually replaced by a permanent set of 32.

DECIDUOUS = to be shed

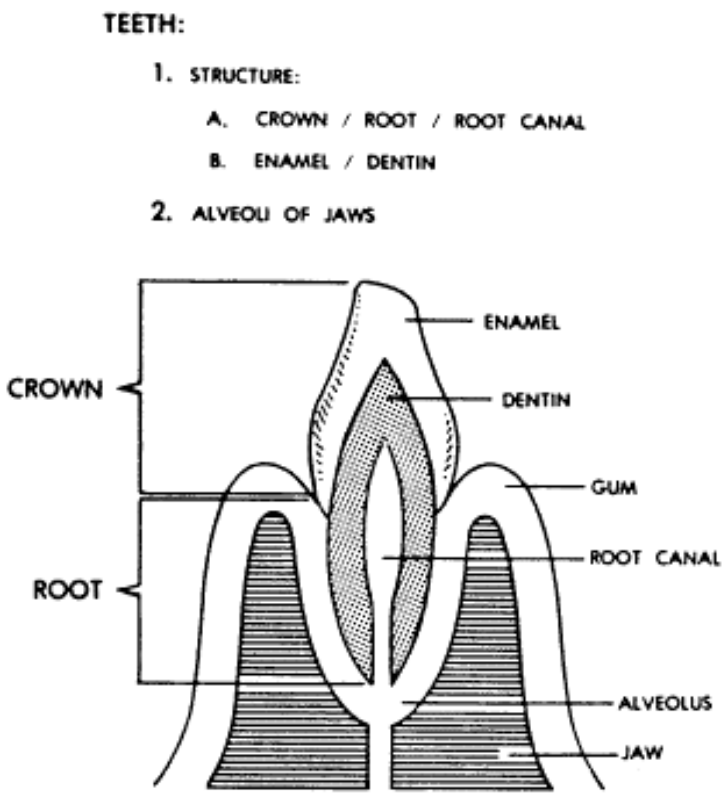


Figure 1-3. Section of a tooth and jaw.

b. **Jaws.** There are two jaws, the upper and the lower. The upper is called the maxilla. The lower is called the mandible.

(1) In each jaw, there are sockets for the teeth. These sockets are known as alveoli. The bony parts of the jaws holding the teeth are known as alveolar ridges.

(2) The upper jaw is fixed to the base of the cranium. The lower jaw is movable. There is a special articulation, (T-MJ, temporo-mandibular joint), with muscles to bring the upper and lower teeth together to perform their functions.

c. **Palate.** The palate serves as the roof of the mouth and the floor of the nasal chamber above. Since the anterior two-thirds is bony, it is called the hard palate. The posterior one-third is musculo-membranous, and is called the soft palate. The soft palate serves as a trap door to close off the upper respiratory passageway during swallowing.

d. **Lips and Cheeks.** The oral cavity is closed by a fleshy structure around the opening. Forming the opening are the lips. On the sides are the cheeks.

e. **Tongue.** The tongue is a muscular organ. The tongue is capable of internal movement to shape its body. It is moved as a whole by muscles outside the tongue. Interaction between the tongue and cheeks keeps the food between the molar teeth during the chewing process. When the food is properly processed, the tongue also initiates the swallowing process.

f. **Salivary Glands.** Digestion is a chemical process that takes place at the wet surfaces of food materials. The chewing process has greatly increased the surface area available. The surfaces are wetted by saliva produced by glands in the oral cavity. Of these glands, three pairs are known as the salivary glands proper.

g. **Taste Buds.** Associated with the tongue and the back of the mouth are special clumps of cells known as taste buds. These taste buds literally taste the food. That is, they check its quality and acceptability.

1-4. PHARYNX

The pharynx (pronounced “FAIR-inks”) is a continuation of the rear of the mouth region, just anterior to the vertebral column (spine). It is a common passageway for both the respiratory and digestive systems.

1-5. ESOPHAGUS

The esophagus is a muscular, tubular structure extending from the pharynx, down through the neck and the thorax (chest), and to the stomach. During swallowing, the esophagus serves as a passageway for the food from the pharynx to the stomach.

Section III. THE STOMACH

1-6. STORAGE FUNCTION

The stomach is a sac-like enlargement of the digestive tract specialized for the storage of food. Since food is stored, a person does not have to eat continuously all day. One is freed to do other things. The presence of valves at each end prevents the stored food from leaving the stomach before it is ready. The pyloric valve prevents the food from going further. The inner lining of the stomach is in folds to allow expansion.

1-7. DIGESTIVE FUNCTION

a. While the food is in the stomach, the digestive processes are initiated by juices from the wall of the stomach. The musculature of the walls thoroughly mixes the food and juices while the food is being held in the stomach. In fact, the stomach has an extra layer of muscle fibers for this purpose.

b. When the pyloric valve of the stomach opens, a portion of the stomach contents moves into the small intestine.

Section IV. THE SMALL INTESTINES AND ASSOCIATED GLANDS

1-8. GENERAL

a. Digestion is a chemical process. This process is facilitated by special chemicals called digestive enzymes. The end products of digestion are absorbed through the wall of the gut into the blood vessels. These end products are then distributed to body parts that need them for growth, repair, or energy.

b. There are associated glands, the liver and the pancreas, which produce additional enzymes to further the process.

c. Most digestion and absorption takes place in the small intestines.

1-9. ANATOMY OF THE SMALL INTESTINES

a. The small intestines are classically divided into three areas, the duodenum, the jejunum, and the ileum. The duodenum is C-shaped, about 10 inches long in the adult. The duodenum is looped around the pancreas. The jejunum is approximately eight feet long and connects the duodenum and ileum. The ileum is about 12 feet long. The jejunum and ileum are attached to the rear wall of the abdomen with a membrane called a mesentery. This membrane allows mobility and serves as a passageway for nerves and vessels (NAVL) to the small intestines.

DUODENUM = Length equal to width of 12 fingers
JEJUNUM = empty
ILEUM = lying next to the illume (bone of the pelvic girdle)
PELVIS = basin

b. The small intestine is tubular. It has muscular walls that produce a wave-like motion called peristalsis moving the contents along. The small intestine is just the right length to allow the processes of digestion and absorption to take place completely.

c. The inner surface of the small intestine is NOT smooth like the inside of new plumbing pipes. Rather, the inner surface has folds (plicae). On the surface of these plicae are fingerlike projections called villi (villus, singular). This folding and the presence of villi increase the surface area available for absorption.

Section V. THE LARGE INTESTINES

1-10. GENERAL FUNCTION

The primary function of the large intestines is the salvaging of water and electrolytes (salts). Most of the end products of digestion have already been absorbed in the small intestines. Within the large intestines, the contents are first a watery fluid. Thus, the large intestines are important in the conservation of water for use by the body. The large intestines remove water until a nearly solid mass is formed before defecation, the evacuation of feces.

1-11. MAJOR SUBDIVISIONS

The major subdivisions of the large intestines are the cecum (with vermiform or "worm-shaped" appendix), the ascending colon, the transverse colon, the descending colon, and the sigmoid colon. The fecal mass is stored in the sigmoid colon until passed into the rectum.

1-12. RECTUM, ANAL CANAL, AND ANUS

Rectum means "straight". However, this six inch tubular structure would actually look a bit wave-like from the front. From the side, one would see that it was curved to conform the sacrum (at the lower end of the spinal column). The final storage of feces is in the rectum. The rectum terminates in the narrow anal canal, which is about 1 1/2 inches long in the adult. At the end of the anal canal is the opening called the anus. Muscles called the anal sphincters aid in the retention of feces until defecation.

Section VI. ASSOCIATED PROTECTIVE STRUCTURES

1-13. GENERAL

Within the body, there are many structures that aid in protection from bacteria, viruses, and other foreign substances. These structures include cells that can phagocytize (engulf) foreign particles or manufacture antibodies (which help to inactivate foreign substances). Collectively, such cells make up the reticuloendothelial system (RES). Such cells are found in bone marrow, the spleen, the liver, and lymph nodes.

1-14. STRUCTURES WITHIN THE DIGESTIVE SYSTEM

Lymphoid structures make up the largest part of the RES. Lymphoid structures are collections of cells associated with circulatory systems.

a. Tonsils are associated with the posterior portions of the respiratory and digestive areas in the head, primarily in the region of the pharynx. The tonsils are masses of lymphoid tissue.

b. Other lymphoid aggregations are found in the walls of the small intestines.

c. The vermiform appendix, attached to the cecum of the large intestine, is also a mass of lymphoid tissue. It is the “tonsil” of the intestines.

Section VII. ACCESSORY STRUCTURES OF THE DIGESTIVE SYSTEM

1-15. THE LIVER

The liver is a massive glandular organ. In fact, the liver is the largest gland in the body. The major function of the liver, as far as digestion is concerned, is the production of bile, a substance that aids in the digestion of lipids (fats). There are salts contained in the bile (bile salts) that help to emulsify fat globules so that they can be digested by intestinal lipases. Bile also aids in making the end products of fat digestion more soluble so that they are absorbed through the intestinal mucosa. Bile is continuously being made and excreted by the liver. Bile is stored in the gallbladder until it is needed. The function of the gallbladder is to store bile and release it when it is needed in the small intestine. The liver also has functions that are not related to the digestive system.

a. **Glycogen Storage.** When carbohydrates are digested and the end product sugars are not immediately utilized by the body, they are made into a substance called glycogen and stored in the liver in that form until needed.

b. **Hematopoiesis.** The liver is an important organ in the hematopoietic system. It functions as a blood reservoir during venous pooling and it polices up iron from destroyed red cells so that it can be used for synthesis of new red cells by the bone marrow.

c. **Phagocytosis.** The liver has phagocytic cells called Kupffer's cells that can remove bacteria and foreign particles from the blood.

d. **Detoxification.** This is not the most accurate word to describe this function, but the liver is responsible for metabolizing many drugs and other substances in the blood from an active to an inactive form. For example, alcohol is active and is metabolized by the liver to an inactive substance and the drink wears off.

e. **Vitamin Storage and Synthesis.** The liver can store large quantities of Vitamins A and B_{12}. It also functions in the synthesis of Vitamin D from precursors in the body, a very important vitamin affecting bone structure and function, and blood Ca++ levels.

f. **Blood Coagulation.** The liver is the organ responsible for the production of fibrinogen, prothrombin, and other factors important in the blood clotting mechanism. Impairment could result in inhibition of the clotting process.

g. **Antibody (Ab) Production.** Antibodies are an important defense mechanism against infection and invasion of body tissues by bacteria. They are formed in the plasma cells found in lymphoid tissue. The liver contains a very large amount of lymphoid tissue, lymph nodes, and lymph. Damage may severely impair the immune process of the body.

1-16. THE PANCREAS

The other accessory organ important to the gastrointestinal tract is the pancreas. The pancreas functions as both an endocrine and exocrine gland and it is the exocrine portion that is concerned with digestion. The pancreas secretes lipases and proteases that are responsible for the digestion of fats and proteins in the small intestine. The endocrine portion of the pancreas is composed of groups of cells scattered throughout the pancreas called the Islets of Langerhans. There are alpha and beta cells in the pancreas. These alpha and beta cells have specific functions. The alpha cells secrete glucagon, a hormone which promotes the breakdown of glycogen and sugar stores and causes their release into the bloodstream. The beta cells secrete insulin, a hormone which promotes the movement of glucose from the bloodstream into the cells and the subsequent oxidation of the glucose. The release of insulin promotes a lowering of blood sugar. Diabetics have insulin deficiency and hence have unusually high blood sugar levels that "spill over" into the urine.

Section VIII. ABSORPTION AND METABOLISM IN THE DIGESTIVE SYSTEM

1-17. INTRODUCTION

Once foodstuffs are taken into the body and have passed through the gastrointestinal tract, their end products are either stored or used by our cells for energy. The only substance that can be used by our body cells for the purpose of obtaining energy is glucose. Our bodies can obtain glucose directly from the absorption and digestion of carbohydrates or from the production of glucose from other substances (if necessary).

1-18. THE DIGESTION OF CARBOHYDRATES

a. The digestion of carbohydrates begins in the mouth by the enzyme alpha-amylase or ptyalin, which is found in saliva. The process of turning complex carbohydrates (starches) into simple disaccharide units thus begins in the mouth. The mouth is very important in the digestion of carbohydrates--food is chewed, mixed with saliva, and swallowed. This occurs within a very short period of time, which allows for only about five percent of the starch to split. As the bolus moves on to the stomach, the low pH of the stomach prevents further action by salivary amylase. Hence, very little further digestion of carbohydrates occurs in the stomach.

b. After the carbohydrates pass into the small intestine, their digestion is completed. In the small intestine, pancreatic amylase acts on the remaining starch and

completely breaks it down to disaccharide (maltose and isomaltose). Sucrose, maltase, isomaltase, and lactase finally break down this disaccharide, along with other disaccharides ingested in foods (sucrose, lactose) to the monosaccharides glucose, fructose, and galactose. These simple sugars are the end products of carbohydrate digestion and are absorbed through the intestinal mucosa into the bloodstream via a carrier-mediated transport system. They can be either oxidized immediately by the cells to do work or they can be stored until they are needed by the body. They can be stored in two ways:

(1) Synthesized to glycogen in the liver, or

(2) Synthesized to fat and stored in fat cells.

1-19. THE DIGESTION OF FAT

a. There is virtually no fat digestion in the mouth or stomach. The first step in the digestion of fats is emulsification, the physical break up of fat globules into small droplets. This occurs in the small Intestine by the action of bile and bile salts. Emulsification permits the digestive enzymes (lipases) to act upon the fat molecules and break them down into monoglycerides, fatty acids, and glycerol, the end products of fat digestion and the form in which they are absorbed through the intestinal mucosa.

b. The absorption occurs through a rather complex and poorly understood mechanism. The end products of lipid digestion can be either oxidized by the cells or transformed into glucose that, in turn, is then oxidized by the cells to do work. They may also be stored as fat.

1-20. THE DIGESTION OF PROTEINS

The digestive process of proteins begins in the stomach. In the stomach, pepsin, an enzyme activated by the low pH of the stomach, breaks apart long chain polypeptides and proteins into simpler short-chain peptides referred to as proteoses and peptones. Further hydrolysis of these fragments to dipeptides and amino acids is accomplished in the small intestine by the enzymes chymotrypsin and trypsin. Ultimately, all peptide fragments are broken down to their constituent amino acids, the end products of protein digestion, by various carboxypeptidases and aminopeptidases present all along the walls of the small intestine. The mechanism by which the amino acids are absorbed across the small intestine walls is poorly understood.

Section IX. DISORDERS AND DISEASES OF THE DIGESTIVE TRACT

1-21. INTRODUCTION

There are several common disorders of the digestive system. Many of these disorders can be treated by drugs that you will dispense in the pharmacy.

1-22. DISORDERS OF THE MOUTH CAVITY

a. **Dental Caries (Tooth Decay).** Dental caries is a weakening or decay of the enamel coating of teeth. If allowed to progress unchecked, eventual destruction of the entire tooth (including the root and pulp) can result. Destruction of the root necessitates extraction.

b. **Mumps.** Mumps are a typical childhood disease in which the salivary glands (principally the parotid) become swollen and inflamed. Mumps are caused by a virus and the condition is highly infectious. There is a vaccine available that can protect persons from mumps.

c. **Trench Mouth (Vincent's Disease).** Trench mouth is an acute inflammation of the gums. Bleeding and pain are usually present. Probably the disease is not communicable and may be due to poor oral hygiene, mononucleosis, or nonspecific viral infection. This disorder is treated with antibiotics and oxygenating mouthwashes such as hydrogen peroxide.

d. **Thrush.** Thrush is due to an overgrowth of a normally occurring oral fungus, Candida albicans. Thrush is characterized by creamy-white, curd-like patches that may occur anywhere in the mouth. Pain and fever are usually present and treatment must include the removal of the causative factor. The patient should have a nutritious diet with adequate intake of vitamins and rest. Saline rinses help promote healing. If thrush is not treated, it can lead to ulcers and stomach problems.

1-23. DISORDERS OF THE STOMACH

a. **Peptic Ulcer.** Probably the best known stomach disease is peptic ulcer. Peptic ulcers are presumed to be caused by the action of pepsin upon the stomach lining until it becomes eroded, exposing the layers of the cells underneath. Continual secretion of stomach acid irritates the exposed layers of the stomach lining resulting in pain and bleeding. There is no specific cure or treatment for ulcers and the cause or initiating factor in the disease process is not known. People who have peptic ulcers usually are told to avoid stress and are maintained on strict diets. Ulcers may eventually erode completely through a region of the stomach (called a perforation) and cause excessive bleeding.

b. **Duodenal Ulcer.** Duodenal ulcers are ulcers that occur in the duodenum, usually along the initial two inch segment just distal to the stomach. The symptoms for a duodenal ulcer are virtually the same as for a stomach ulcer, but duodenal ulcers are much more common and death due to perforation and hemorrhage is a major problem. Duodenal ulcers also appear to penetrate other organs (migration of the ulcerative crater). Treatment usually consists of preventing or controlling stress in the patient and maintaining the patient on a strictly controlled diet and administering certain drugs (like sucralfate or cimetidine). Although the ulcer will "heal" in three to four weeks, periodic

recurrence has never successfully been prevented. The origin of the condition is not understood.

c. **Cancer.** The stomach is susceptible to cancer or neoplasms of the mucosal lining. A cancer is an uncontrollable growth of cells. Neither the cause nor the cure for cancer of the stomach is known. If discovered early, surgery can prove beneficial.

1-24. DISORDERS OF THE INTESTINES

a. **Sprue.** Sprue, or malabsorption of nutrients from the small intestine, can be very serious. It usually involves impaired absorption of fats and vitamins that leads to vitamin deficiency and anemia (inadequate red blood cell count). Treatment of sprue usually consist s of a high carbohydrate, low protein, low fat diet with vitamin supplements. Emergency replenishment of vital nutrients, if necessary, can be accomplished by intravenous injection.

b. **Diarrhea.** Diarrhea is the frequent excretion of excessive, soft, or watery stools. In some cases, the excretion may be totally liquid. Nausea and vomiting may be present. Although the condition is obviously unpleasant for the patient, mild diarrhea is usually not serious. However, if a patient has severe diarrhea, loss of nutrients and electrolytes may occur which requires replacement therapy and medical care. Cholera, a very serious condition, is characterized by a large loss of fluids and nutrients in watery stools.

c. **Colitis.** Colitis is simply an inflammation of the colon that sometimes results in diarrhea. If the condition is ulcerative colitis, then changes in the colon wall and scar tissue formation may result. Anemia, malaise, and weakness may be present. Treatment of colitis usually consists of rest, careful administration of anti-infectives, and restricted diet. Symptoms usually go away after a period of two to three weeks, but there is no cure for the condition.

d. **Appendicitis.** Appendicitis is simply an inflammation of the veriform appendix, usually due to an obstruction. Treatment consists of surgical removal. If left untreated, perforation into the peritoneal cavity with generalized peritonitis usually results.

e. **Hemorrhoids (Piles).** Hemorrhoids (or piles) are ulcerations of the hemorrhoidal vein (a vein which lies in close proximity to the external mucosa of the anus). Pain, itching, and general discomfort are the usual symptoms associated with hemorrhoids. However, complications such as infection or obstruction may arise. It is surgically possible to remove hemorrhoids.

f. **Hepatitis.** There are two types of hepatitis, serum (or long-term incubation) and <u>infectious</u> (or short-term incubation). Infectious hepatitis is spread via the oral route and the danger of an epidemic exists in close environments such as military bases and hospitals. Serum hepatitis is transmitted by blood transfusion or by the use of an

unsterilized syringe or “dirty” needle. The incubation period for hepatitis ranges from six weeks to six months. The type of hepatitis a patient has can be identified in some patients. There can be a wide variety of clinical symptoms and signs of hepatitis ranging from mild infection to death. The disease is usually centered in the liver and jaundice (yellow coloration of skin) is usually present along with hepatomegaly (enlarged liver). Liver damage may result in hepatitis. Most patients recover from hepatitis. Bed rest is usually required during the first phase of the disease. Hepatitis is viral in nature. Therefore, there is no specific treatment or cure other than to let the disease run its course. The physician treating a person who has hepatitis must carefully observe the patient and treat symptoms and complications when they arise.

g. **Cirrhosis.** Cirrhosis is a disease of the liver characterized by degeneration and necrosis of liver cells with fatty deposits. Although the specific cause is unknown, malnutrition, vitamin deficiency, and alcoholism definitely are causative factors and contribute to progression of the disease process. The liver has a number of vital functions in the body and, hence, cirrhosis is a serious condition. A wide variety of symptoms may be present, but treatment almost always consists of adequate rest, abstinence from alcohol, and a carefully selected diet. Vitamin supplements may be necessary for the patient. There is no “cure” for cirrhosis and the outlook for the improvement of the patient is not good. Only 50 percent of the patients who have cirrhosis survive beyond two years and only 35 percent survive beyond five years.

h. **Cholecystitis.** Cholecystitis is an inflammation of the gallbladder. An infection may be the source of the inflammation. If an infection is present, the patient may be prescribed antibiotics. Cholecystitis is usually treated by placing the patient on a low-fat diet. The gallbladder may be surgically removed if the inflammation becomes too severe.

i. **Cholelithiasis.** Cholelithiasis is the presence of gallstones, calcified deposits of cholesterol, bilirubin, and bile salts. Cholecystitis usually must be treated with the surgical removal of the gallstones.

j. **Diabetes Mellitus.** Diabetes mellitus is insulin deficiency. This insulin deficiency results in the inability of body cells to take up and use glucose. Therefore, the glucose (sugar) remains in the blood and the blood levels eventually rise to extremely high levels and eventually “spill over” into the urine. This is one of the classic signs of diabetes mellitus. There is no cure for diabetes mellitus--treatment consists of insulin replacement therapy with commercially available insulin and a very strictly controlled diet.

k. **Ascites.** Ascites is edema or the presence of fluid in the peritoneal cavity. Ascites can be caused by a variety of factors, with cardiac or renal insufficiency or disease being the most common.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. The human digestive system is best defined as:

   a. A group of organs intended to provide energy to the body.

   b. A group of organs designed to take in, process, and digest foods and eliminate unused materials of food items.

   c. A group of organs involved in the absorption of foods.

   d. A group of organs which convert food into simpler substances which can be used by the body.

2. Which of the organs below is/are in the human digestive system?

   a. Esophagus.

   b. Spleen.

   c. Large intestines.

3. Select the function(s) of the stomach.

   a. The digestion of food.

   b. The initiation of food digestion.

   c. The salvaging of water and electrolytes from the food.

4. The esophagus is best described as:

    a. A continuation of the rear of the mouth region which is just anterior to the vertebral column.

    b. A structure with tubular muscular walls that has villi on the inner surfaces which moves the food through an action called peristalsis.

    c. A mass of lymphoid tissue that is located just anterior to the stomach.

    d. A muscular, tubular structure that serves as a passageway for the food from the pharynx to the stomach.

5. Which of the statements below best describes the digestion of fats?

    a. Fats are emulsified by bile and bile salts in the small intestine and absorbed as fatty acids in the large intestine.

    b. Fats are emulsified in the stomach and then broken down to fatty acids, monoglycerides, and glycerol which are absorbed in the small intestine.

    c. Fats are emulsified by bile and bile salts in the large intestine and are then absorbed as fatty acids and glucose through the intestinal mucosa.

    d. Fats are emulsified in the stomach and are absorbed as fatty acids, monoglycerides, and glycerol through the intestinal mucosa.

6. What is the major function of the liver (as far as digestion is concerned)?

    a. The production of insulin.

    b. The production of bile.

    c. The production of fatty acids and monoglycerides.

    d. The production of Vitamins A and B_{12}.

7. Mumps is best described as a viral infection of the:

    a. Salivary glands.

    b. Liver.

    c. Esophagus.

    d. Ileum.

8. Appendicitis is best described as:

    a. An inflammation of the veriform appendix typically caused by an obstruction.

    b. An inflammation of the liver characterized by degeneration and necrosis of the cells with fatty deposits.

    c. An inflammation of the colon which sometimes results In diarrhea.

    d. An inflammation of the small intestines due to an Infection usually caused by a gallstone.

9. Ascites is:

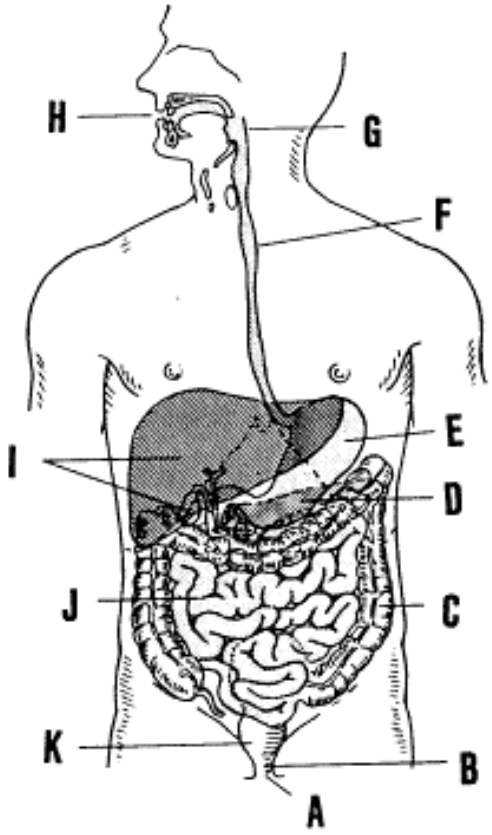
    a. An inflammation of the gallbladder due to infection that is usually precipitated by a gallstone.

    b. An inflammation of the colon that usually results in diarrhea.

    c. A condition in which there is malabsorption of nutrients from the small intestine.

    d. Edema or the presence of fluid in the peritoneal cavity.

SPECIAL INSTRUCTIONS FOR EXERCISES 10 THROUGH 12. The drawing below is used in questions 10, 11, and 12. Match the question in Column A to its correct location in Column B.



10. Which letter is pointing to the pancreas? _____

11. Which letter is pointing to the small intestines? _____

12. Which letter is pointing to the rectum? _____

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. b (para 1-1a)
2. a and c (para 1-1b (3), (6))
3. a and b (para 1-6, 1-7)
4. d (para 1-5)
5. b (para 1-19)
6. b (para 1-15)
7. a (para 1-22b)
8. a (para 1-24d)
9. d (para 1-24k)
10. D (Figure 1-1)
11. J (Figure 1-1)
12. K (Figure 1-1)

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2 Antacids and Digestants.

LESSON ASSIGNMENT Paragraphs 2-1 through 2-6.

LESSON OBJECTIVES After completing this lesson, you should be able to:

2-1. Given a group of statements and one of the following terms: antacid or digestant, select the statement that best defines the given term.

2-2. Given a group of indications, select the indication(s) for the use of antacids or digestants.

2-3. From a group of statements, select the statement that describes a consideration involved in the selection of an antacid for use.

2-4. Given the trade and/or generic name of an antacid or digestant product and a group of uses, actions, indications, side effects, or cautions and warnings, select the use(s), indication(s), side effect(s), or caution(s) and warning(s) associated with that product.

2-5. Given the trade or generic name of an antacid or digestant product and a list of trade and/or generic names, select the trade or generic name which corresponds to the given trade or generic name.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

ANTACIDS AND DIGESTANTS

Section I. ANTACIDS

2-1. INTRODUCTION

Many of the patients you will see at the outpatient pharmacy window will be there to receive antacid preparations. You will usually see these patients every several months because they will return to obtain more antacids. Thus, one can see that many of the patients who take antacid preparations will be taking them for many years. You must be familiar with the antacid preparations so that you can adequately serve these patients.

2-2. GENERAL CONSIDERATIONS FOR ANTACIDS

a. **Definition.** Antacids are drugs which neutralize part of the hydrochloric acid in the stomach.

b. **Indications for the Use of Antacids.** Antacids are indicated in ulcer therapy, minor stomach irritations, and other conditions depending on the type of antacid prescribed.

c. **Factors Considered When an Antacid is Prescribed.** Before a patient is prescribed a particular antacid preparation, the prescriber must consider the patient's condition as well as a group of other factors. Some of these factors are listed below:

(1) Gastric acid neutralization. The chief reason for prescribing an antacid preparation is the neutralization of the hydrochloric acid in the stomach. Antacid preparations contain one or more drugs which chemically neutralize this hydrochloric acid. Not all chemicals neutralize the same amount of stomach acid on a weight-by-weight basis. Therefore, the prescriber must be aware of the active ingredient(s) present in an antacid preparation and how effectively that preparation is able to neutralize stomach acid in relation to other antacid preparations.

(2) Effect on systemic pH. Most antacid agents remain in the gastrointestinal system when they are taken to neutralize stomach acid. However, some agents (e.g., sodium bicarbonate ($NaHCO_3$)), because of their ability to ionize, are capable of going into systemic circulation in the bloodstream once they are ingested. For example, if enough sodium bicarbonate is ingested, the bicarbonate ion (HCO_3) can be systemically absorbed and affect the pH of the blood. This effect is highly undesirable.

(3) Speed of action. It is desirable that an antacid product act quickly once it has been ingested.

(4) Acid rebound.

(5) Drug interactions.

(6) Other side effects specific to individual agents.

2-3. ANTACID PREPARATIONS

a. **Sodium Bicarbonate ($NaHCO_3$).** Sodium bicarbonate is used as a gastric antacid, urinary alkalizing agent, and an agent used to counteract the lowering of the pH of the blood in heart failure (raising the pH of the blood during heart failure increases the pharmacological effectiveness of epinephrine). The usual dosage of sodium bicarbonate is 0.3 to 2 grams as needed. Side effects associated with this agent include systemic alkalization (raising the pH of the blood) and acid rebound. The patient receiving sodium bicarbonate for antacid purposes should be told that it should not be used frequently and that it should not be used for prolonged periods. Sodium bicarbonate is available in tablets of various strengths and in powder form.

b. **Calcium Carbonate and Glycine (Titralac®).** Titralac® is used as a gastric antacid. The usual dosage of this product is from one to four tablets or from one to four teaspoonsful four times daily. Side effects associated with this product include acid rebound and systemic alkalization. The patient receiving this product should be cautioned not to use it for prolonged periods. Persons receiving the tablets should be told to chew them thoroughly before swallowing them. Patients receiving the suspension should be told to shake the preparation well before taking the medication. Titralac® is available in both suspension form (1 gram calcium carbonate and 300 milligrams of glycine per 5 milliliters) and tablet form (300 milligram tablets and 600 milligram tablets).

c. **Magnesium Hydroxide (Milk of Magnesia).** Magnesium hydroxide is used both as an antacid and as a cathartic (laxative). The antacid dose of milk of magnesia (MOM) is one to two teaspoonsful as needed. The cathartic dose of MOM for adults is one to two tablespoonsful taken with one or more glasses of water. Patients taking this product should be cautioned that they can obtain the laxative effect if they take too large a dose or if they take the antacid dose too often. A side effect associated with MOM is diarrhea. Patients who receive MOM in suspension form should be told to shake the suspension thoroughly, while patients taking the tablet form of the product should be cautioned to chew the tablets thoroughly.

d. **Aluminum Hydroxide (Amphojel®).** Aluminum hydroxide is used as a gastric antacid and as an agent in ulcer therapy. The usual dose of aluminum hydroxide is one teaspoonful to two tablespoonsful of the suspension four or more times daily or one to four tablets four or more times daily. Constipation is a side effect associated with the use of aluminum hydroxide. When you dispense the tablets, you should tell the patient to chew them thoroughly before swallowing them. When you dispense the suspension, you should tell the patient to shake the container well before taking the dose. Aluminum hydroxide is available in both suspension form (320 milligrams per teaspoonful) and in tablet form (300 and 600 milligram tablets).

e. **Magaldrate (Riopan®).** Magaldrate is used as a gastric antacid and as an agent in the treatment of ulcers. It acts as a buffer/antacid. Side effects associated with magaldrate include constipation and diarrhea. This preparation is available in three forms: suspension, chew tablets, and swallow tablets. The information you provide the patient when dispensing the product depends on the particular dosage form being dispensed:

(1) Suspension. Tell the patient to shake the container well. The usual dosage of this form is one or two teaspoonsful between meals and at bedtime.

(2) Chew tablet. Tell the patient to chew the tablet(s) thoroughly before swallowing. The usual dosage of the chew tablets is one to two tablets between meals and at bedtime.

(3) Swallow tablet. Tell the patient to take the tablet(s) with enough water to swallow them properly. The usual dosage of the swallow tablet is one or two tablets between meals and at bedtime.

CAUTION: Magaldrate should not be taken by persons who are taking a prescription antibiotic drug containing any form of tetracycline.

f. **Aluminum Hydroxide and Magnesium Hydroxide (Maalox®).** Maalox® is used as a gastric antacid and as an agent in ulcer therapy. This product is available in both a suspension form (225 milligrams of aluminum hydroxide and 200 milligrams of magnesium hydroxide per teaspoonful) and in tablet form (200 milligrams of aluminum hydroxide and 200 milligrams of magnesium hydroxide per tablet). Depending on the amount of the preparation taken, diarrhea and constipation are side effects associated with the product.

g. **Aluminum Hydroxide and Magnesium Trisilicate Tablets (Gaviscon®).** This tablet product is used as a gastric antacid and as a protectant for the lower esophagus. Gaviscon® produces a foam when ingested. This foam floats on the stomach contents. Thus, the foam protects the delicate mucosa of the esophagus from irritation when stomach contents are forced into the esophagus. Gaviscon® produces a local effect--the entire stomach contents are not neutralized. The usual dose is two to four tablets four times daily, after meals and at bedtime. Side effects of this product, depending on the dose, are either diarrhea or constipation. When you dispense these tablets to the patient, you should tell him to chew them thoroughly before swallowing. Each tablet has 80 milligrams of aluminum hydroxide and 20 milligrams of magnesium trisilicate.

h. **Aluminum Hydroxide and Magnesium Carbonate Liquid (Gaviscon® liquid antacid).** Like the product in paragraph g above, this liquid antacid preparation is used as a gastric antacid and as a protectant for the lower esophagus. The usual dose of this product is one to two tablespoonsful four times daily. The product contains 95 milligrams of aluminum hydroxide and 412 milligrams of magnesium carbonate in each 15 milliliters (one tablespoonful). When you dispense this product to a patient, tell him that the container should be shaken well before the dose is taken.

i. **Simethicone (Mylicon®).** Simethicone is used as an antiflatulent. An antiflatulent is a product which relieves the painful symptoms of excess gas in the gastrointestinal system by breaking apart mucous surrounded gas pockets or preventing their formation. The usual dose of this product is 40 to 80 milligrams four times daily after meals and at bedtime. When you dispense this product in tablet form, you should tell the patient to chew the tablet(s) thoroughly before swallowing. Mylicon® is supplied in two forms--tablets (40 or 80 milligrams per tablet) and drops (40 milligrams per 0.6 milliliters).

j. **Aluminum Hydroxide, Magnesium Hydroxide, and Simethicone (Mylanta®, Gelusil®).** This product is used as a gastric antacid, antiflatulant, and as an agent useful in ulcer therapy. The side effects associated with this preparation (depending on the dose) are diarrhea and constipation. This product is available in both suspension and tablet form. The formulation of the product by form basis is below:

	Aluminum Hydroxide	**Magnesium Hydroxide**	**Simethicone**
Tablets	200 milligrams	200 milligrams	25 milligrams (Gelusil®)
Suspension (per 5 milliliters)	200 milligrams	200 milligrams	20 milligrams (Mylanta®)

CAUTION: When you dispense the tablets, you should tell the patient to chew them thoroughly before swallowing. When you dispense the suspension, you should tell the patient to shake the container well before taking the dose.

k. **Other**. Many other antacid preparations are stocked in military and civilian pharmacies. You should use available references (Physicians' Desk Reference, United States Pharmacopeia Dispensing Information, etc.) to discover any specific information you want to learn about a particular product. Some of these products are:

(1) Aluminum carbonate (Basojel®).

(2) Dihydroxyaluminum sodium carbonate (Rolaids®).

(3) Dihydroxyaluminum amino acetate.

(4) Aluminum phosphate (Phosphajel®).

(5) Magnesium oxide.

(6) Magnesium carbonate.

Section II. DIGESTANTS

2-4. DEFINITION

Digestants are a group of drugs used to promote the process of digestion in the gastrointestinal tract.

2-5. INDICATION OF DIGESTANT THERAPY

A digestant is indicated when there is evidence of insufficient functioning of some part of the digestive system responsible for producing a substance necessary for the digestion of food. Viewed from this area, the digestants are substances used in deficiency states. Digestants commonly employed are the choleretics (e.g., bile salts), pancreatic enzymes, and hydrochloric acid.

2-6. EXAMPLES OF DIGESTANTS

a. **Glutamic Acid Hydrochloride.** Glutamic acid hydrochloride is used in the treatment of patients who are either secreting no stomach acid (achlorhydria) or are secreting little stomach acid (hypochlorhydria). Once prepared, the acid solution is sipped through a glass straw in order to minimize damage to the teeth.

b. **Dehydrocholic Acid, NF.** Dehydrocholic acid is used to increase the volume of bile produced and secreted in the digestive system. It is used to relieve excessive constipation as well as to remove fragments of gallstones from the body. The usual dose of this drug is 3 to 5 milliliters of a 20 percent solution administered intravenously.

c. **Pancrelipase (Cotazyme®).** This product is used as a pancreatic enzyme supplement. The usual dosage of pancrelipase is one to three capsules or one to two packets of the powder before or with meals. The preparation is available in both capsule or powder (regular and cherry flavor). When you dispense the granules, tell the patient to mix the granules with food or with water.

d. **Pancreatin (Panteric®).** Pancreatin is used as a pancreatic enzyme supplement. The usual dosage of the product is one to three tablets with meals.

e. **Other**. Other digestants are commonly stocked in military and civilian pharmacies. To learn of the specific uses and side effects of these agents, you should read a reference such as Physicians' Desk Reference. Examples of these digestants are:

(1) Glutamic acid hydrochloride (Acidulin®).

(2) Ox bile extract.

(3) Ox bile extract, pancreatin, pepsin, glutamic acid, hydrochloride, and cellulose (Kanulase®).

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. A digestant is defined as:

   a. A drug used to promote the process of digestion in the gastrointestinal tract.

   b. A product used to reduce the amount of hydrochloric acid in the stomach.

   c. A drug used to break apart mucous--surrounded gas pockets in order to relieve painful symptoms of excess gas.

   d. A drug used as an antiflatulent.

2. Antacids are indicated in the treatment of:

   a. Minor stomach irritations.

   b. Flatulence.

   c. Ulcers.

   d. Both a and b above.

   e. Both a and c above.

3. Which of the following is a consideration involved in the selection of an antacid?

   a. The speed at which the antacid neutralizes stomach acid.

   b. The amount of the antacid required to neutralize the stomach acid.

   c. The tendency of the antacid to be absorbed systemically and affect the blood pH.

   d. All of the above.

4. From the statements below, select the one which describes a consideration involved in the selection of an antacid.

    a. Whether or not the antacid has a tendency to produce acid rebound.

    b. The degree to which the antacid acts as an antiflatulent.

    c. The inability of the antacid product to ionize in the intestines.

    d. The ability of the product to produce catharsis.

5. Titralac® is used as a(n):

    a. Pancreatic enzyme replacement.

    b. Gastric antacid.

    c. Laxative/antacid.

    d. Antiflatulent.

6. Magnesium hydroxide (milk of magnesia) is used as a(n)

    a. Laxative and an antiflatulent.

    b. Laxative and an antacid.

    c. Antacid and an antiflatulent.

    d. Digestant and an antiflatulent.

7. Calcium carbonate and glycine has what side effect(s)?

    a. Acid rebound.

    b. Systemic alkalization.

    c. Both a and b above.

8. A patient is about to receive Gaviscon® tablets. What caution and warning should be told to the patient?

    a. Swallow the tablets without chewing them.

    b. Chew the tablets thoroughly before you swallow.

    c. The tablets should not be taken by a person who has hypotension.

    d. The tablets should be quickly swallowed in order to avoid damage to the tissues of the mouth.

9. You have just dispensed some pancrelipase granules to a patient. Which of the statements below should you tell the patient?

    a. Chew the tablets before swallowing.

    b. Do not take the granules within two hours after taking a prescription antibiotic.

    c. Mix the granules with food or with water.

    d. Mix the granules in orange juice and swallow the solution quickly to avoid damage to the tissues of the mouth.

10. Dehydrocholic acid, NF, is used to:

    a. Provide hydrochloric acid to patients whose stomachs make little or no stomach acid.

    b. Stimulate the production of insulin in patients who have diabetes mellitus.

    c. Reduce flatulence.

    d. Increase the volume of bile produced and secreted in the digestive system.

SPECIAL INSTRUCTIONS FOR EXERCISES 11 THROUGH 14. In exercises 11 through 14, match the trade name in Column B with its corresponding generic name in Column A.

		Column A	Column B
11.	____	Aluminum hydroxide, magnesium hydroxide, and simethicome	a. Cotazyme®
12.	____	Pancrelipase	b. Mylanta®
13.	____	Calcium carbonate and glycine	c. Mylicon®
14.	____	Simethicone	d. Titralac®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. a (para 2-4)
2. e (para 2-2b)
3. d (para 2-2c)
4. a (para 2-3c(4))
5. b (para 2-3b)
6. b (para 2-3c)
7. c (para 2-3b)
8. b (para 2-3g)
9. c (para 2-6c)
10. d (para 2-6b)
11. b (para 2-3j)
12. a (para 2-6c)
13. d (para 2-3b)
14. c (para 2-3i)

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3 Emetics, Antiemetics, and Antidiarrheals.

LESSON ASSIGNMENT Paragraphs 3-1 through 3-8.

LESSON OBJECTIVES After completing this lesson, you should be able to:

3-1. Given one of the following terms: emetic, antiemetic, or antidiarrheal and a group of statements, select the statement that best defines the given term.

3-2. Given a group of situational statements and one of the following terms: emetic, antiemetic, or antidiarrheal, select the statement that best describes an indication for the use of that type of agent.

3-3. Given the trade and/or generic name of an emetic, antiemetic, or antidiarrheal and a group of indications, uses, side effects, cautions or warnings, or patient instructions, select the indication(s), use(s), side effect(s), caution(s) or warning(s), or patient instruction(s) for the given agent.

3-4. Given the trade or generic name of an emetic, antiemetic, or antidiarrheal and a list of trade and/or generic names, select the corresponding trade or generic name for the given drug name.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

EMETICS, ANTIEMETICS, AND ANTIDIARRHEALS

Section I. OVERVIEW

3-1. INTRODUCTION

Emetics, antiemetics, and antidiarrheals are three categories of drugs that affect the gastrointestinal system. Each category of agents has its own distinct use for the relief of patient discomfort. You must be familiar with these agents in order to provide the patient with information which will enhance the medication's therapeutic effect and/or provide greater patient safety and comfort.

3-2. DEFINITIONS

Before any discussion is made of individual categories and specific agents, it is necessary for you to learn/review the definition of each of these categories.

a. **Emetic.** An emetic is a chemical agent which will cause the patient to vomit (i.e., produce emesis). Emesis is sometimes indicated when a patient ingests certain chemical substances.

b. **Antiemetic.** An antiemetic is an agent which prevents or alleviates nausea and vomiting. Antiemetics are sometimes used to treat the nausea and vomiting associated with motion sickness, pregnancy, or an illness.

c. **Antidiarrheal.** An antidiarrheal is an agent used to control diarrhea. Antidiarrheals are sometimes prescribed to patients who have severe diarrhea.

Section II. EMETICS

3-3. INTRODUCTION

An emetic is a chemical agent that will cause the patient to vomit (i.e., to produce emesis). A physician may administer an emetic to a patient who has ingested a certain type of chemical substance. Emetics are not indicated for all poisonings. Prior to administering an emetic to a poisoning victim, the local poison control center should be consulted to determine if this is the best procedure to follow.

3-4. EXAMPLES OF EMETIC AGENTS

a. **Ipecac Syrup, USP.** Ipecac syrup is a clear, amber, hydroalcoholic preparation used in the treatment of poisoning and/or drug overdoses. This product acts by stimulating the chemoreceptor trigger zone and by irritating the gastric mucosa. Emesis usually occurs within 15 minutes after ingestion. The recommended dose of

ipecac syrup is one or two teaspoonsful in children who are less than one year old and three teaspoonsful in persons over one year old. To aid emesis, one or two glasses of water or fruit juice can be ingested after the ipecac syrup is taken. Carbonated beverages, milk, or activated charcoal should not be taken with this product. In particular, milk and activated charcoal are thought to decrease the effectiveness of ipecac syrup. If it is thought necessary to administer activated charcoal, the activated charcoal should be given after emesis has occurred.

b. **Ipecac Tincture and Ipecac Fluidextract.** Ipecac syrup, USP, has replaced ipecac tincture and ipecac fluidextract as the preferred form of ipecac. Ipecac fluidextract is 14 times more concentrated than ipecac syrup. Hence, giving the patient three teaspoonsful of ipecac fluidextract can be potentially dangerous to the patient.

Section III. ANTIEMETICS

3-5. INTRODUCTION/INDICATIONS FOR ANTIEMETIC THERAPY

Antiemetics are agents which prevent or alleviate nausea and vomiting. These agents are indicated when the physician wishes to prevent or alleviate nausea and vomiting, especially when it is associated with motion sickness, pregnancy, or an illness. For example, a child with the flu, with serious vomiting, can lose large volumes of fluid. An antiemetic can help to reduce that vomiting with a resultant reduction in fluid loss.

3-6. EXAMPLES OF ANTIEMETICS

a. **Prochlorperazine (Compazine®).** Prochlorperazine is an agent that is widely used to control severe nausea and vomiting. As an antiemetic, the usual oral dose is five to 10 milligrams three or four times a day. When given rectally in suppository form, the dose is 25 milligrams two times a day. Intramuscular injection in a dosage of 5 to 10 milligrams a day is sometimes ordered, the patient may repeat the dosage every three to four hours, but the total dosage should not exceed 40 milligrams per day. Compazine is supplied as 5, 10, and 25 milligram tablets; 2.5, 5, and 25 milligram suppositories; and 5 milligrams per milliliter injection. When you dispense this product, tell the patient that prochlorperazine may cause drowsiness and warn him to avoid taking the product with alcohol.

b. **Trimethobenzamide (Tigan®).** Trimethobenzamide is indicated for use as an antiemetic in the treatment of nausea and vomiting. The usual side effect associated with this drug is drowsiness. Patients taking this product should be warned not to take it with alcohol. The usual oral dose of trimethobenzamide is 250 milligrams three to four times daily, while the rectal and injection routes of administration have the usual dosage of 200 milligrams given three to four times daily. This product is supplied as 100 to 250 milligram capsules, 200 milligram suppositories, and 100 milligrams per milliliter intramuscular injection.

c. **Dimenhydrinate (Dramamine®).** Dimenhydrinate has been used for many years in the treatment of motion sickness. The usual side effect associated with the administration of this agent is drowsiness. The patient taking this medication should be informed about the drowsiness and that alcohol should not be consumed while taking this drug. Dimenhydrinate has as its usual dose one tablet two hours before travel, then one tablet every four hours as needed for nausea and vomiting. Dramamine® is supplied as a 50 milligram tablet.

d. **Meclizine (Bonine®).** Meclizine is an antiemetic normally used in the treatment of motion sickness. It is frequently prescribed for vertigo; hence, one company's trade name for meclizine is Antivert®. Drowsiness is the most prominent side effect associated with this product. You should inform the patient of this side effect when you dispense it. Likewise, you should tell the patient that meclizine should not be taken with alcohol. The usual dose for motion sickness is 25 to 50 milligrams one hour before travel. This dose may be taken every 24 hours if necessary. In the treatment of vertigo (dizziness), the recommended dose is 25 to 100 milligrams per day in divided doses. Bonine® is supplied as 25 milligram chewable tablets, while Antivert® is available in 12.5 and 25 milligram tablets.

Section IV. ANTIDIARRHEALS

3-7. INTRODUCTION

Antidiarrheals are agents used to control diarrhea. Antidiarrheals are indicated in patients who have severe diarrhea. Antidiarrheals not only can make life more pleasant for persons so afflicted, they can really prevent the body from losing a great volume of fluid.

3-8. EXAMPLES OF ANTIDIARRHEAL AGENTS

a. **Attapulgite (Kaopectate®).** It is used for its adsorbent and protectant action. This product is effective for minor diarrhea. The usual dose of Kaopectate® is two to four tablespoonsful after each loose bowel movement.

b. **Paregoric.** The active ingredient in paregoric is its morphine component. This morphine component is helpful in treating diarrhea because it reduces the intestinal motility and digestive secretions. The result is that the movement of the stool through the small and large intestines is slowed. This effect allows more water to be absorbed out of the stool. This helps produce a stool of a more solid mass. Furthermore, paregoric causes the tone of the anal sphincter to be increased and this, combined with the dulling of the sensation to defecate aids in the constipating effect of the drug. The patient taking paregoric should be cautioned against taking the drug with alcohol or any other central nervous system (CNS) depressant. Furthermore, the patient should be informed that the product can cause drowsiness. The usual dosage of paregoric is 5 to 10 milliliters (one to two teaspoon(s)full four times a day. Paregoric is supplied as a liquid. It is a Note Q item.

c. **Diphenoxylate with Atropine (Lomotil®).** Lomotil® is an antidiarrheal that acts by slowing intestinal motility. Since this drug may cause drowsiness, patients taking it should be cautioned about this. Theoretically, at high doses Lomotil® can be addicting. Therefore, Lomotil® is a Note Q item. A subtherapeutic dose of atropine is added to the product to discourage deliberate overdosage. The usual dose of Lomotil® is one or two tables four times a day. It is supplied in tablet form, each tablet contains 2.5 milligrams of diphenoxylate and 0.025 milligram of atropine sulfate and in liquid form containing the same amount of each drug in 5 milliliters (one teaspoonful) of solution.

d. **Loperamide (Imodium®).** Loperamide is another drug which acts by slowing intestinal motility. Since this agent may cause drowsiness, the patient should be cautioned against doing anything requiring mental alertness while taking the drug. Imodium® is supplied in the form of 2 milligram capsules. The usual dose is 4 milligrams (two capsules) immediately, then 2 milligrams (one capsule) after each loose bowel movement.

e. **Attapulgite (Parepectolin®).** Attapulgite is used in the treatment of diarrhea. A side effect associated with this agent is stool may temporarily appear gray-black. Also if diarrhea is accompanied by high fever or continues for more then 2 days, consult physician. The patient should be informed of this side effect.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. An emetic is best defined as:

   a. A chemical agent that will prevent or alleviate nausea and vomiting.

   b. A chemical agent that will produce diuresis.

   c. A chemical agent that will control fluid bowel movements.

   d. A chemical agent that will cause a person to vomit.

2. An antidiarrheal is indicated in some instances in which the patient:

   a. Has severe diarrhea with resultant fluid loss.

   b Has soft stool.

   c. Has nausea and vomiting.

   d. Has intestinal cramps and stomach pain.

3. Lomotil® is used as a(n):

   a. Antiemetic.

   b. Laxative.

   c. Antidiarrheal.

   d. Emetic.

4. The patient taking paregoric should be cautioned:

   a. That the product can produce central nervous system (CNS) stimulation.

   b. Not to take the product with alcohol or any other central nervous system depressant.

   c. To take the product only on a full stomach.

   d. That the product can produce excess intestinal gas.

5. Meclizine is a product normally used in the treatment of:

   a. Motion sickness.

   b. Diarrhea.

   c. Stomach cramps.

   d. Flatulence.

6. The side effect usually associated with trimethobenzamide is:

   a. Nausea.

   b. Drowsiness.

   c. Vomiting.

   d. Diarrhea.

7. Dramamine is used in the treatment of:

   a. Drug overdoses.

   b. Vertigo.

   c. Motion sickness.

   d. Diarrhea.

8. Patients taking Compazine® should be warned:

   a. Not to take the drug with carbonated beverages, milk, or activated charcoal.

   b. That the drug can cause severe constipation.

   c. Not to take the drug with alcohol.

   d. That the drug can produce nausea and vomiting.

9. Kaopectate® is used in the treatment of:

   a. Stomach cramps.

   b. Drug overdoses.

   c. Excess gas in the gastrointestinal tract.

   d. Minor diarrhea.

SPECIAL INSTRUCTIONS FOR EXERCISES 10 THROUGH 13. In exercises 10 through 13, match the trade name in Column B with its corresponding generic name in Column A.

Column A	Column B
10. ___ Meclizine	a. Lomotil®
11. ___ Diphenoxylate with Atropine	b. Imodium®
12. ___ Prochlorperazine	c. Compazine®
13. ___ Loperamide	d. Bonine®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. d (para 3-3)
2. a (para 3-7)
3. c (para 3-8c)
4. b (para 3-8b)
5. a (para 3-6d)
6. b (para 3-6b)
7. c (para 3-6c)
8. c (para 3-6a)
9. d (para 3-8a)
10. d (para 3-6e)
11. a (para 3-6a)
12. c (para 3-6a)
13. b (para 3-8d)

End of Lesson 3

LESSON ASSIGNMENT

LESSON 4	Cathartics.
LESSON ASSIGNMENT	Paragraphs 4-1 through 4-10.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

4-1. Given a group of statements, select the statement that best defines the term cathartic.

4-2. From a group of statements, select the statement that best describes the cathartic (laxative) habit.

4-3. Given a list of factors, select those factors that can help most people maintain normal bowel habits.

4-4. Given a group of statements, select the statement(s) which best describe(s) precautions associated with the use of cathartics.

4-5. Given a group of statements, select the information statement that should be told to persons taking cathartics.

4-6. Given the name of one of the categories of cathartics (by mechanism of action) and a group of statements, select the statement that best describes the mechanism of action for that cathartic category.

4-7. Given the trade and/or generic name of a cathartic and a list of categories of cathartics (by mechanism of action), select the category for which that particular agent belongs.

4-8. Given the name of one of the five categories of cathartics (by mechanism of action) and a group of statements, select the statement that describes an important dosage consideration, precaution, or patient information associated with that category

4-9. Given the trade and/or generic name of a cathartic and a group of uses, side effects, cautions and warnings, or patient information statements, select the use(s), side effect(s), caution(s), and warnings or patient information statement(s) associated with the given agent.

4-10. Given the trade or generic name of a cathartic agent and a list of trade and/or generic names, select the corresponding trade or generic name of the given agent.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 4

CATHARTICS

Section I. INTRODUCTION

4-1. OVERVIEW

Cathartics are a group of drugs which cause an evacuation of the bowel (i.e., bowel movement). This group is one of the most abused categories of drugs. Why? The answer is simple, most people believe that something is wrong with them if they don't have at least one bowel movement a day.

4-2. DEFINITION OF A CATHARTIC

A cathartic is any agent which causes an evacuation of the bowel (i.e., causes a bowel movement). You may have heard the term laxative used instead of cathartic. Not all cathartics have to be purchased in a drug store. Remember, food such as prunes and bran may be categorized as cathartics because of their ability to cause evacuation of the bowels.

4-3. THE CATHARTIC (LAXATIVE) HABIT

The physician seldom has the opportunity to prescribe cathartics, except in the hospital setting, since valid indications for the use of laxatives are limited. More commonly, the physician is faced with the problem of chronic misuse of these agents by his patients. The task the physician faces is a difficult one; the patient must be helped to break the cathartic habit. The cathartic habit is the extensive, chronic misuse of self-prescribed cathartics by a bowel-conscious person. Cathartics are taken by many people because they believe they must have a bowel movement at least once each day.

4-4. THE NORMAL FUNCTIONING OF THE BOWELS

The digestive process, from the intake of food to the elimination of the waste products from that ingestion, may take from one to three days depending on the composition of the food. The number of times a healthy person defecates can vary from once or twice a day to one bowel movement every one or two days. Many persons who don't know a great deal about bowel habits often take cathartics so they can have daily bowel movements. After a while, this results in an inability of the bowel to be stimulated by normal body function. The person then begins to rely entirely on the ingestion of cathartics for bowel movements. This is known as the cathartic habit. Time and education are required before the person can remove this dependence upon cathartics.

4-5. FACTORS WHICH HELP TO MAINTAIN NORMAL BOWEL HABITS

The following factors, if followed, can help most people maintain normal (whatever that means for each person) bowel habits without the use of cathartics.

a. **Exercise.** Exercise helps to maintain muscle tone.

b. **Proper Diet.** Ingesting foods containing high fiber content provides the bulk needed by the digestive system for normal bowel functioning.

c. **Fluids.** Each person should drink several glasses of water a day (unless this is not allowed by the physician) in order to give the body the water it needs for the proper functioning of all its systems.

d. **Routine.** Slow down and relax. Establish a time and a place (i.e., a routine) where you can relax and have bowel movements.

4-6. PRECAUTIONS ASSOCIATED WITH THE USE OF CATHARTICS

It is important that persons not believe that they should take a cathartic every time they fail to have a daily bowel movement. The precautions below are important in that they provide some basic guidelines dealing with the ingestion of cathartics.

a. Do not take a cathartic within two hours after having taken another drug. Taking a drug with a cathartic will have an effect upon the absorption of that drug, it may result in either more or less of the drug being absorbed.

b. Do not take a cathartic if you do not have a bowel movement for several days.

c. Do not take a cathartic just to take one. Some persons believe it is therapeutic to periodically take a cathartic. This is not true. In fact, too frequently taking a cathartic can result in a patient's having the "laxative habit."

d. Do not take a cathartic if you developed a skin rash after having taken it the last time.

e. Do not take a cathartic for more than one week unless your physician has told you otherwise.

f. Do not take a cathartic if you have the following signs --tenderness in the stomach or lower abdominal area, soreness in the abdomen, bloating, vomiting, or nausea.

Section II. CATHARTIC AGENTS

4-7. INTRODUCTION

Not all cathartics have the same mechanism of action. In fact, there are several categories of cathartics, each has a particular mechanism of action. These categories are bulk-forming cathartics, lubricant cathartics, stimulant cathartics, emollient cathartics (also known as stool softeners), and hyperosmotic cathartics.

4-8. IMPORTANT INFORMATION FOR PERSONS TAKING CATHARTICS

Persons who take cathartics should be told of the importance of drinking extra fluids. In fact, a person who is taking a laxative should drink at least six to eight full glasses of fluid (each glass should be equal to 8 fluid ounces, 240 milliliters). This extra fluid helps the cathartic to produce its effects faster. Certain cathartics (e.g., those in the bulk-forming category) require fluid in addition to the six to eight glasses of fluid they should be drinking. This additional fluid should be taken when ingesting the cathartic.

4-9. MECHANISMS OF ACTION OF CATHARTICS

Each category of cathartics has its own particular mechanism of action. The mechanisms of action are important because the physician may select a particular agent because of the specific favorable results obtained as a direct effect of a mechanism of action.

a. **Bulk-Forming Cathartics.** These cathartics absorb water and provide bulk for the gastrointestinal tract. The increased bulk provides stimulation to the bowels (peristalsis).

b. **Lubricant Cathartics.** Lubricant cathartics increase the fluid level in the small intestines. They do this by coating the surfaces of the stool and the intestines. This coating results in decreased absorption of water and increase in the volume of water in the intestines. This effect also eases the flow of stool through the intestines by lubrication.

c. **Stimulant Cathartics.** Stimulant cathartics increase the rate of peristalsis in the intestine by directly acting on the smooth muscle of the intestine.

d. **Emollient Cathartics.** Emollient cathartics reduce the surface film tension of the stool. This allows for fluids to penetrate the stool and thus to make the stool softer.

e. **Hyperosmotic Cathartics.** Hyperosmotic cathartics are concentrated solutions of substances which draw water into the intestine. Increased water content of the stool further stimulates peristalsis.

4-10. CATEGORIES AND SPECIFIC EXAMPLES OF CATHARTICS

Many cathartics are on the shelves of military and civilian pharmacies. You can help yourself (and your patients) if you are able to categorize a specific agent into a particular category of agents. Why? Because each category of cathartics has certain general information that pertain to drug interactions, side effects, and patient precautionary statements. Therefore, if you are able to correctly categorize an agent, you should be able to predict side effects and precautionary statements related to that product. The information below provides you with general information pertaining to each category of drugs. Invest some time learning this material. Specific statements pertaining to side effects and precautionary statements will not be repeated when the individual agents are discussed.

a. **Bulk-Forming Cathartics.** The person taking a bulk-forming cathartics should be told to drink a full glass of fluid (one glass = 8 fluid ounces = 240 milliliters) when ingesting the cathartic. Persons taking bulk-forming cathartics should not expect immediate results. Instead, they should be told that the bulk-forming cathartics take from one to three days to produce their effects. Furthermore, it is generally recommended that the patient taking antibiotics, anticoagulants, digitalis preparations, or salicylates wait at least two hours after they take a dose of these drugs before they ingest the cathartics. This is recommended because the interaction between the drug and the cathartic could result in less of the drug being absorbed. Side effects are rare with the bulk-forming cathartics. However, intestinal impaction has occurred in patients who did not drink enough water while taking the products. The cathartic habit does not occur with bulk-forming laxatives. Consequently, they are sometimes prescribed for extended use.

(1) Malt soup extract (Maltsupex®). This product is available in tablet, liquid, and powder form. Label these products “Take with a full glass of water."

(2) Methylcellulose (Cellothyl®). Methylcellulose is available in tablet, capsule, solution, and powder form. Label these products “Take with a full glass of water.”

(3) Polycarbophil calcium (Mitrolan®). This product is available in tablet form. The patient should be told to chew or crush the tablets before swallowing them.

NOTE: This product is sometimes given at 1/2 hour intervals in the treatment of diarrhea.

(4) Psyllium (Effersyllium®, Serutan®). This product is available in powder form. The powder should be placed in 1/2 glass of water (one full teaspoonful in 1/2 glass of water). When the product is dispensed, tell the patient to keep the container in a dry place and keep it tightly capped.

b. **Lubricant Cathartics.** Lubricant cathartics are usually ingested at bedtime. The patient should not take a lubricant cathartic with meals, since this could interfere with the absorption of food, vitamins, and minerals in the gastrointestinal tract. Furthermore, patients should be warned not to take lubricant cathartics for long periods because of the absorption problems (e.g., reduced absorption of vitamins) associated with their use. Lubricant laxatives usually provide results within 12 hours after ingestion. Lastly, patients taking lubricant cathartics should be cautioned to protect their clothing, since some leakage might occur from the rectum.

Product: Mineral Oil (Nujol®). The oral dosage of this product, one to three tablespoonsful, is usually given at bedtime. Several strengths of this product are available (emulsion-50%; jell-55%; and plain-100%).

c. **Stimulant Cathartics.** Side effects associated with stimulant cathartics include belching, diarrhea, and cramping. Stimulant cathartics should be taken on an empty stomach in order to produce faster effects. Potassium loss, cramping, the laxative habit, and pinkish urine or stool are effects associated with stimulant cathartics.

(1) Bisacodyl (Dulcolax®). Bisacodyl is available in tablet form (five milligrams per tablet). The usual dose is two to three tablets. Only one dose of the medication is taken. The tablets should be swallowed whole with a full glass of water (8 fluid ounces = 240 milliliters). The patient taking this product should be warned not to chew or crush the tablet (the contents have a bitter taste). Furthermore, the patient should be cautioned not to take this product within one hour after taking antacids or milk, since these products may cause the enteric coating of the tablet to be prematurely removed in the stomach and result in gastric irritation.

(2) Cascara (Cas-Evac®). Cascara is available as the aromatic cascara fluid extract and as cascara tablets. Persons receiving the fluid extract should be told to thoroughly shake the container before taking the dose. Persons taking either product should be told that cascara can discolor the urine.

(3) Castor oil (Alphamul®, Neoloid®). Castor oil is available in an emulsified form as well as in an aromatic form. The usual adult dose of this product is from one to four tablespoonsful.

(4) Danthron (Dorbane®). This product is available in both tablet and solution form. The solution dosage form contains five percent ethyl alcohol. Persons taking this drug should be warned that their urine may become discolored because of the preparation.

(5) Dehydrocholic acid (Decholin®). This product is available in 250 milligram tablets. The usual adult dose of dehydrocholic acid is one tablet three or four times a day. This product is not recommended for patients under 12 years of age.

(6) Phenolphthalein (Alophen®, Evac-U-Gen®, Ex-Lax®, Feen-A-Mint®). Phenolphthalein is available in the form of chewing gum, tablets, and chewable tablets. Patients taking the gum should be told to chew the gum well and not to swallow it. Patients receiving this product should be told that phenolphthalein may discolor their urine.

(7) Senna (Black Draught®, Fletcher's Castoria®). Senna is available in a variety of forms. Patients taking this product should be told that it may discolor their urine.

d. **Emollient Cathartics.** Skin rashes, gastric cramping, and irritated throats (with liquid preparations) are sometimes associated with emollient agents. In general, emollients are used to soften hard, dry stools in order to ease defecation. Results are not immediately obtained with emollient cathartics. Instead, it takes approximately one to three days for this type of cathartic to produce results after the first dose is taken. Patients taking emollient cathartics should be cautioned not to take mineral oil or other laxatives since they might be absorbed to a greater degree. Since some emollient products have a rather bitter taste, the patient can take the preparations with milk or fruit juice to mask the unpleasant taste. Emollient cathartics will not produce the cathartic habit, but they will increase absorption through the lipid membrane. Consequently, they are not prescribed for extended periods.

(1) Docusate calcium (Surfak®). Docusate calcium is available in 50 and 240 milligram tablets. The usual adult dose of the product is one (240 milligram) tablet a day taken with a full glass of water. Ensure that you tell the patient to drink adequate fluids while taking the medication, since this will enhance the stool softening effect of the medication. Docusate is available in several salts (calcium, potassium, and sodium) and in several dosage forms. Docusate sodium is a product available under the trade name of Colace®.

(2) Poloxamer 188 (Alxin®, Magcyl®). This product is available in 240 and 250 milligram capsules. The usual adult dose of Poloxamer 188 is one capsule one to three times a day with a glass of water.

e. **Hyperosmotic Cathartics.** Hyperosmotic cathartics are divided into two categories, lactulose and saline cathartics. Because saline cathartics tend to produce nonabsorbable complexes with tetracyclines, patients taking saline cathartics should be cautioned not to take them within one to three hours after taking tetracycline. Saline cathartics produce rapid results--defecation is achieved within two to eight hours after taking the product. Therefore, the person should not take a saline cathartic late at night or immediately before going to bed. Since some saline cathartics contain sugar and/or sodium, diabetics and persons who must reduce their intake of sodium should check each product for its composition. Saline cathartics should not be given to children six years of age and under.

(1) Lactulose (Chronulac®). Lactulose is available in syrup form with 10 grams of lactulose per tablespoonful. The usual adult dose of this product is from one to two tablespoonful a day. This product should be protected from freezing. The prolonged exposure of this product to high temperatures may produce a darkening of the product; however, the darkening does not decrease the therapeutic effectiveness of the active ingredient. When you dispense this product, you should tell the patient that the dose may be combined with water, milk, or fruit juice to improve the taste. Lactulose produces results in one to two days.

(2) Magnesium citrate (citrate of magnesia). This product is available in the form of an effervescent solution. The usual oral dose of this product is 200 milliliters of the solution. The solution may lose some of its effervescence upon standing, but this does not reduce its therapeutic effectiveness (although it does affect the taste of the product).

(3) Magnesium sulfate crystals (epsom salts). This product is supplied in crystal form which is to be dissolved in water before taking. The usual adult dose of the product is 15 grams in a glass of water (8 fluid ounces = 240 milliliters) as one dose. The crystals may be placed in a lemon-lime carbonated beverage in order to improve the taste.

(4) Sodium phosphate (Fleets Phospho-Soda®). Sodium phosphate is available in the form of effervescent sodium phosphate powder and sodium phosphate oral solution. The powder should be dissolved in one full glass of water and then ingested (adult dose--10 to 20 grams per glass of water). The usual adult dose of the oral solution is 10 to 40 milliliters (as one dose) mixed in a glass of water (240 milliliters). You should note that sodium phosphate contains large amounts of sodium. This information is important for persons who must restrict their intake of sodium.

Continue with Exercises

EXERCISES, LESSON 4

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. The term cathartic is best defined as an agent that:

   a. Causes an evacuation of the bowel.

   b. Produces emesis.

   c. Causes the bowels to move on a daily basis.

   d. Softens the stool in order to produce a bowel movement with less effort.

2. Which of the following can help people maintain normal bowel habits?

   a. Establishing a time of day when they can relax and have a bowel movement.

   b. Eating foods high in protein and carbohydrates.

   c. Eating food which is soft and not bulky.

   d. All of the above.

3. What precaution(s) is/are associated with the use of cathartics?

   a. Do not take a cathartic if there is tenderness in the stomach or lower abdominal area.

   b. Do not take a cathartic if a skin rash developed immediately after the last dose of the drug was taken.

   c. Do not take a cathartic just for the sake of taking one.

   d. All of the above.

4. Select the statement that best describes the mechanism of action of emollient cathartics.

   a. These agents increase the fluid level In the small intestines which helps move the ingested material through the bowels.

   b. These agents increase the rate of peristalsis in the intestine by directly acting on the smooth muscle of the intestine.

   c. These agents reduce the surface film tension of the stool allowing fluids to penetrate the stool and make the stool softer.

   d. These agents absorb water and provide bulk for the gastrointestinal tract.

5. Phenolphthalein (Alophen®) is classified as a(n) _____ cathartic.

   a. Lubricant.

   b. Emollient.

   c. Bulk-forming.

   d. Stimulant.

6. Mineral oil (Nujol®) is classified as a(n) _____ cathartic.

   a. Emollient.

   b. Lubricant.

   c. Stimulant.

   d. Bulk-forming.

7. A patient taking a lubricant cathartic should be told:

   a. To take the product on an empty stomach in order to obtain faster results.

   b. Not to take this type of cathartic for a long period because this cathartic can decrease the absorption of vitamins from the gastrointestinal tract.

   c. That this type of agent usually requires two to three days to produce a bowel movement.

   d. Take the product with an emollient cathartic in order to produce faster results.

8. Patients taking senna (Black Draught®) should be told:

   a. The drug may discolor their urine.

   b. They should not take the product for a long period because it can interfere with vitamin absorption in the gastrointestinal tract.

   c. They should protect their clothing since some leakage of the product may occur from the rectum.

   d. They should not expect the product to produce bowel movements until three to four days after they initially take the product.

9. Select the special labeling information which should be included on the label when you dispense methylcellulose (Cellothyl®) tablets.

   a. “Chew tablets thoroughly before swallowing.”

   b. “Warning: This product may cause your urine to become pinkish.”

   c. “Protect this product from light since light may cause discoloration.”

   d. “Take with a full glass of water.”

10. Patients taking polycarbophil calcium tablets should be told to:

    a. Avoid chewing or crushing the tablets because of their bitter taste.

    b. Chew or crush the tablets before taking them.

    c. Expect their urine to be pinkish or red in color because of the medication.

    d. They should take the medication with milk or fruit juice to mask the medication's unpleasant taste.

SPECIAL INSTRUCTIONS FOR EXERCISES 11 THROUGH 14. In exercises 11 through 14, match the trade name in Column B with its corresponding generic name in Column A.

Column A	Column B
11. __ Bisacodyl	a. Dulcolax®
12. __ Lactulose	b. Chronulac®
13. __ Psyllium	c. Ex-Lax®
14. __ Phenolphthalein	d. Serutan®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 4

1. a (para 4-2)
2. a (para 4-5)
3. d (para 4-6)
4. c (para 4-9d)
5. d (para 4-10c(6))
6. b (para 4-10b)
7. b (para 4-10b)
8. a (para 4-10c(7))
9. d (para 4-10a(2))
10. a (para 4-10a(3))
11. a (para 4-10c(1))
12. b (para 4-10e(1))
13. d (para 4-10a(4))
14. c (para 4-10c(6))

End of Lesson 4

LESSON ASSIGNMENT

LESSON 5 Fluid and Electrolyte Therapy

LESSON ASSIGNMENT Frames 1 through 81 (programmed text) and Paragraphs 5-1 through 5-10.

LESSON OBJECTIVES After completing this lesson, you should be able to

5-1. Given one of the categories of body fluid and a group of statements, select the statement that best describes that type of body fluid.

5-2. From a group of statements, select the definition of an electrolyte.

5-3. Given a list of the names of electrolytes, select the electrolyte which is the primary positive electrolyte in either intracellular fluid or extracellular fluid.

5-4. Given the name of an electrolyte and a group of functions, select the function performed by that electrolyte.

5-5. From a list of means by which fluids and electrolytes are lost from the body, select those which are either normal or abnormal means of fluid and electrolyte loss.

5-6. Given a group of statements, select the statement that describes the effect an intravenously administered hypertonic solution might have on the cells near the administration site.

5-7. Given a group of statements, select the statement that describes the effect an intravenously administered hypotonic solution might have on the cells near the administration site.

5-8. Given a group of statements, select the statement that describes the effect an intravenously administered acidic or alkaline solution might have on the cells near the administration site.

5-9. Given a list of volumes, select the maximum recommended volume of intravenous fluid that should be administered to an adult during a 24-hour period.

5-10. From a group of statements, select the statement that defines fluid and electrolyte maintenance therapy.

5-11. From a group of statements, select the statement that defines fluid and electrolyte replacement therapy.

5-12. Given one of the two basic categories of intravenous preparations (intravenous solutions or intravenous admixtures) and a group of statements, select the statement that best describes the given type of preparation.

5-13. From a list of characteristics, select the requirements of intravenous preparations.

5-14. Given a group of statements, select the statement that best describes a precaution pertaining to intravenous fluid therapy.

5-15. From a list of possible complications, select the possible complication(s) of intravenous fluid therapy.

5-16. Given the name of one of the types of intravenous fluid and a group of statements, select the statement that best describes the use of that type of fluid.

5-17. Given the name of an intravenous fluid and a list of the categories of intravenous fluids, select the category to which the given intravenous fluid belongs.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

INSTRUCTIONS

This text is set up differently from most subcourse lessons. The first section of this lesson uses a programmed instruction format. The numbered "frames" present information and/or a question about presented information. You should work through the frames in the order presented. Answer each question that is presented. To check your answers, go to the shaded box of the NEXT frame. For example. the solution to the question presented in Frame 7 is found in the shaded box of Frame 8.

DISCLAIMER

The language used in this subcourse was chosen to make the lesson easier to understand and may not be as precise as definitions and terminology you will learn in the future.

FRAME 1

Section I. INTRODUCTION TO FLUID AND ELECTROLYTE PHYSIOLOGY

SPECIAL NOTE: The material in Section I, Fluid and Electrolyte Therapy, is presented to you in the form of a programmed text. The content of this section is designed to review the basic concepts of fluid and electrolyte therapy. An understanding of the principles set forth in this section is essential for a thorough understanding of the use of intravenous solutions. The questions and answers dispersed throughout the programmed text will take the place of the practice exercises usually seen at the end of the lesson. The remaining sections of this lesson will be presented in their usual format.

GO TO FRAME 2.

FRAME 2

The average size person (154 pounds or 70 kilograms) has water amounting to 60 to 70 percent of his total body weight. Electrolytes are found in body fluids. Electrolytes are chemical compounds which are ionized in the aqueous solutions of the body. These electrolytes perform essential physiological functions in the body. Fluctuations in the levels of body fluids and/or electrolytes can result in illness and even death.

FRAME 3

As a person who prepares sterile products, you will have the responsibility of preparing sterile solutions which are meant to be intravenously administered to patients. These solutions will always consist of sterile water. Many times these solutions will also have electrolytes (like sodium chloride) added.

FRAME 4

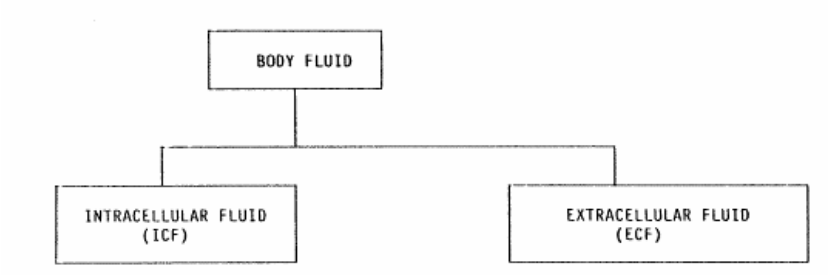
In this module, the topic of fluid and electrolyte therapy will be discussed. Parts of this module will be a review for many of you, while others will be learning these concepts for the first time. In either event, the knowledge you gain during this time will give you a broader background in fluid and electrolyte therapy.

FRAME 5

The first portion of this module discusses fluid and electrolyte distribution in the body. These principles form a foundation for the remainder of the module.

FRAME 6

As previously mentioned, the average 70 kilogram adult's body weight is approximately 60 to 70 percent water. This water is divided into two primary types. These two types are the intracellular fluid and the extracellular fluid. These two types can be represented as below:



FRAME 7

QUESTION: What are the two primary types of body fluids.

a. _____.

b. _____.

FRAME 8 The first type of fluid we shall discuss is the intracellular fluid (ICF), that fluid which is contained inside the body cells. Intracellular fluid composes approximately two-thirds of a person's total body water and approximately 50 percent of the person's body weight.	Solution to Frame 7 **ANSWER:** Intracellular fluid (ICF) Extracellular fluid (ECF)
FRAME 9 The intracellular fluid serves several functions. One, it serves as a transporting medium in that it carries food and oxygen into the cells and wastes and carbon dioxide from the cells. The intracellular fluid also maintains the shape and size of each cell in the body.	
FRAME 10 **QUESTION:** The intracellular fluid composes approximately _____ percent of a person's body weight.	
FRAME 11 The second type of body fluid is the extracellular fluid. The extracellular fluid is located outside the body cells. The extracellular fluid (ECF) composes approximately one-third of the water contained in the body and it accounts for approximately 20 percent of a person's body weight. The extracellular fluid also has several functions. One, it carries nutrients and oxygen to the cells and waste materials from the cells. Also, it serves to bathe the cells in order to keep the cells moist.	Solution to Frame 10 **ANSWER:** The intracellular fluid composes approximately 50% of a person's body weight.

FRAME 12

QUESTION: State the body's two major types of fluids and the approximate percentage of total body water each contains.

BODY FLUID	APPROXIMATE % OF TOTAL BODY WATER
a. _____	_____
b. _____	_____

FRAME 13

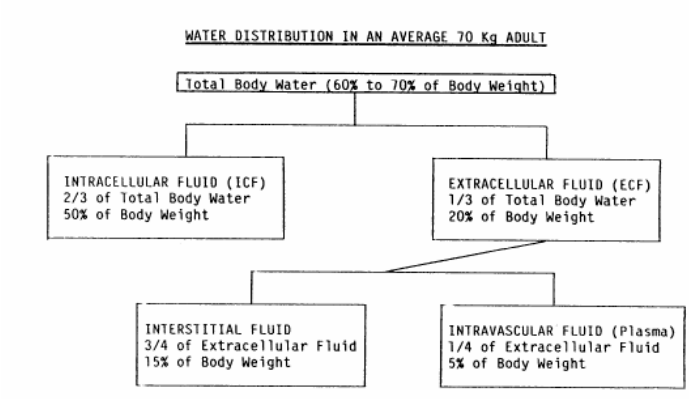
The body's extracellular fluid can be further divided into two types, interstitial fluid and intravascular fluid. The interstitial fluid surrounds cells and it serves as a transporting medium to carry materials to and from cells. Approximately three-fourths of the extracellular fluid is contained in the interstitial fluid. Interstitial fluid accounts for approximately 15 percent of a person's body weight. The second division of the extracellular fluid is the intravascular fluid (plasma). The intravascular fluid is found in the body's circulatory system. It accounts for approximately five percent of a person's body weight.

Solution to Frame 12

Answer:

BODY FLUID	APPROXIMATE % OF TOTAL BODY WATER
Intracellular Fluid	2/3 (or 66.6%)
Extracellular Fluid	1/3 (or 33.3%)

FRAME 14


WATER DISTRIBUTION IN AN AVERAGE 70 Kg ADULT
Total Body Water (60% to 70% of Body Weight)
INTRACELLULAR FLUID (ICF)
2/3 of Total Body Water
50% of Body Weight
EXTRACELLULAR FLUID (ECF)
1/3 of Total Body Water
20% of Body Weight
INTERSTITIAL FLUID
3/4 of Extracellular Fluid
15% of Body Weight
INTRAVASCULAR FLUID (Plasma)
1/4 of Extracellular Fluid
5% of Body Weight

FRAME 15

QUESTION: State the two main types of fluid found in the body.

a. _____.

b. _____.

FRAME 16

QUESTION: The extracellular fluid composes approximately _____ percent of total body water and _____ percent of body weight.

Solution to Frame 15

ANSWER:
Intracellular fluid (ICF)

Extracellular fluid (ECF)

FRAME 17

QUESTION: The intracellular fluid composes approximately _____ percent of total body water and _____ percent of body weight.

Solution to Frame 16

ANSWER: The extracellular fluid composes approximately 33% of total body water and 20% of body weight.

FRAME 18

The amount of intracellular and extracellular fluid contained in a person s body is extremely important to his proper physiological functioning. Losses of body fluids by vomiting, diarrhea, and perspiration can produce illness. Whenever body fluids are lost, certain substances are also lost. For example, diuretics produce increased urine flow. Electrolytes like potassium are lost in this urine. Electrolytes, ions like potassium and chloride, are inorganic substances which are found in solution in body fluids. Therefore, a loss of body fluids usually means a corresponding loss of electrolytes. The particular ion(s) and the number of each ion lost will depend upon whether the fluid lost arises from the interstitial fluid or the intravascular fluid. The situation is complicated by the fact that fluid can move from one type of fluid compartment to another.

Solution to Frame 17

ANSWER: The intracellular fluid composes approximately 66% of total body water and 50% of body weight.

FRAME 19

Below are the major electrolytes and the amount of each contained in a liter of extracellular fluid.

Sodium (Na^{+})	140 mEq
Chloride (Cl^{--})	100 mEq
Bicarbonate ($HC0_3$)	27 mEq
Potassium (K^{+})	4 mEq
Magnesium (Mg^{+2})	3 mEq

FRAME 20

QUESTION: What is the most abundant positive

ion found in extracellular fluid? _____.

FRAME 21

Solution to Frame 20

ANSWER: Sodium (Na^{+}) is the most abundant positive ion in extracellular fluid.

Electrolytes are also found in intracellular fluid. Below is a listing of the major electrolytes found in intracellular fluid. The concentrations are listed in terms of milliequivalents of the electrolytes per liter of the fluid.

ELECTROLYTE	**NO. OF MILLIEQUIVALENTS PER LITER**
Potassium (K^{+})	160
Phosphate ($P0_4^{-3}$)	110
Magnesium (Mg^{-2})	25
Sodium (Na^{+})	5
Chloride (Cl^{--})	3

FRAME 22

QUESTION: What is the primary positive

electrolyte present in intracellular fluid? _____

FRAME 23

In the earlier sections of this module, the distribution of body fluids and electrolytes was discussed. It has been previously stated that electrolytes are essential in the proper physiological functioning of the body. In this section, the primary physiological function(s) of the major body electrolytes will be discussed.

First, sodium (Na^+) is the most abundant positive electrolyte in extracellular fluid. Sodium is essential in maintaining the osmotic pressure of extracellular fluid.

Solution to Frame 22

ANSWER: Potassium is the primary positive electrolyte in intracellular fluid.

FRAME 24

Chloride is the most abundant negative electrolyte present in extracellular fluid. The chloride ion is essential in maintaining the normal osmotic pressure of extracellular fluid. The chloride ion is also found in the stomach as a result of the ionization of hydrochloric acid (HCl).

FRAME 25

Potassium is the most abundant positive electrolyte present in intracellular fluid. Postassium is required for the conversion of dextrose into energy in the body. Potassium also helps to maintain the osmotic pressure of intracellular fluid, as well as aid in the transmission of nervous impulses within the heart.

FRAME 26

The bicarbonate radical helps maintain the acid-base balance in the body.

FRAME 27

The phosphate radical is essential in the formation of bones and teeth and in the formation of body enzymes.

FRAME 28

Magnesium is essential in the formation of enzymes in the body.

FRAME 29

Finally, calcium is essential in the formation of bones and teeth. It also plays key roles in the clotting of blood and in maintaining the rhythm of the heart beat.

FRAME 30

As you have seen, concentrations of body electrolytes are expressed in units called milliequivalents (mEq). The concentration of these electrolytes are expressed in the number of milliequivalents present in a liter of solution (mEq/L).

FRAME 31

Whenever fluid is lost from the body, certain electrolytes tend to be lost with the fluid. A liter of extracellular fluid contains approximately 140 mEq of sodium. Therefore, if a liter of extracellular fluid were lost from the body, the sodium lost in that fluid would have to be replaced along with the liter of fluid. To further complicate matters, extracellular fluid in the stomach has a different electrolyte composition than extracellular fluid in the intestine. Therefore, a liter of fluid lost during severe vomiting would not contain the same electrolytes (in regard to type and number) as a liter of fluid lost during a severe case of diarrhea. Therefore, in replacing lost fluid, the type of fluid lost and the volume of lost fluid must be closely monitored.

FRAME 32

Up to now, body fluids and electrolytes have been discussed. Normally, people are unaware of the loss or gain of body fluids or electrolytes, it is only when one begins to lose a large volume of fluid through diarrhea and vomiting that this loss becomes acutely apparent. Just think of a time when you experienced acute fluid loss. You will have to agree that the body usually does a superb job of maintaining fluid and electrolyte balance.

FRAME 33

Each and every day the body loses fluids and electrolytes. These fluid and electrolyte losses are normal. These fluid losses normally occur through four main routes, perspiration, digestion, respiration, and urination.

FRAME 34

First, perspiration is that fluid which is lost through the skin. Normally, a person is unaware of perspiration unless the temperature is extremely hot or strenuous exercise has just taken place. Perspiration contains approximately 45 mEq of sodium, 4.5 mEq of potassium, and 57.5 mEq of chloride in each liter.

FRAME 35

NOTE: Most people have difficulty grasping the significance of the volume of perspiration lost during a 24-hour period of time. In order to illustrate this point, the next question will ask you to estimate the volume of fluid lost during a 24-hour period of time in the form of perspiration. Do not attempt to find this figure in the above paragraph. Sufficient data has not been provided for an accurate estimate. Do not be surprised if your estimate is off by 25 or 50 milliliters.

FRAME 36

QUESTION: About _____ ml of fluid lost in the form of perspiration over a 24-hour period of time.

FRAME 37

A small volume of fluid is lost every day in the feces. Usually only 100 milliliters of fluid is lost in normal stools. This demonstrates the efficiency of the large intestine in absorbing the water passing through it. A third means of fluid loss is by respiration. Respiration occurs around-the-clock; however, most people are unaware that they are exhaling fluid (water vapor) every time they breathe. This fluid loss through the lungs only becomes apparent during cold weather. During cold weather, the water vapor can be seen when it is exposed to low temperatures.

Solution to Frame 36

ANSWER: Approximately 650 milliliters of perspiration is lost during a normal day by a normal individual.

FRAME 38

NOTE: Most people have difficulty grasping the significance of the volume of fluid lost during a 24-hour period of time during respiration. In order to illustrate this point, the next question will ask you to estimate the volume of fluid lost during a day in respiration. Do not attempt to find this figure in the above paragraph.

FRAME 39

QUESTION: Estimate the volume of fluid lost in a 24-hour period of time in respiration.

_____ milliliters

FRAME 40

Solution to Frame 39

ANSWER: Approximately 450 milliliters of fluid are lost during a 24-hour period of time in respiration.

The fourth major route of normal fluid loss is through urination. The volume of urine excreted during a 24-hour period of time will vary; however, the normal person will excrete approximately 1,300 milliliters of urine in 24-hours. One liter of urine will contain approximately 75 mEq of sodium, 40 mEq of potassium, and 80 mEq of chloride.

FRAME 41

Adding these normal fluid losses:

PERSPIRATION	650 ml/day
FECES	100 ml/day
RESPIRATION	450 ml/day
URINATION	1,300 ml/day
	2,500 ml/day

Approximately 2,500 milliliters of fluid are normally lost during a 24-hour period of time by the average individual.

FRAME 42

QUESTION: In order to maintain body fluid balance, approximately _____ milliliters of fluid must be taken into the body during each 24 hour period of time.

FRAME 43

A person normally loses approximately 2,500 milliliters of fluid each day. Most people are unaware that these fluid losses are occurring because the losses are replaced as they occur. For example, a person drinks a 240 ml soft drink; then he might go directly to the restroom (latrine) and urinate 240 milliliters. How often have you had a spot of tea only to find yourself needing to go to the restroom several minutes later?

Solution to Frame 42

ANSWER: In order to maintain body fluid balance, approximately 2,500 milliliters of fluid must be taken into the body during each 24-hour period of time.

FRAME 44

Abnormal losses of fluid are not subtle. Everyone is aware when abnormal fluid losses occur. Obviously, the most obvious fluid losses occur when a person suffers from severe vomiting and diarrhea. However, more subtle abnormal fluid losses can occur.

FRAME 45

Vomiting, a very noticeable way of losing fluids, accounts for more fluid loss than one would expect. That is, a person who experiences severe vomiting not only loses those fluids he has taken orally, he also loses fluids (like gastric juices) which are secreted into the stomach. Gastric juices are rich in electrolytes. For example, a liter of gastric juice contains approximately 50 mEq of bicarbonate.

FRAME 46

A second way fluids are abnormally lost is by diarrhea. Most people have had “bugs” that cause diarrhea, loose, watery stools. Not only is diarrhea unpleasant, it also accounts for a large loss of body fluids. Diarrhea causes a loss of fluids and electrolytes (to include sodium, potassium, and chloride). In addition, the digested nutrients present in the diarrhea are not absorbed by the body. Thus, after a bout with severe diarrhea, weakness promptly ensues.

FRAME 47

QUESTION: List two of the most obvious abnormal ways fluids and electrolytes are lost from the body.

a. _____.

b. _____.

FRAME 48

A third means of abnormal fluid loss is by severe perspiration. Strenuous exercise in a hot environment can lead to this excessive perspiration. Sodium, potassium, and chloride are examples of electrolytes lost in perspiration.

Solution to Frame 47

ANSWER:

Vomiting.

Diaherra.

FRAME 49

Fourth, severe burns can cause an abnormal loss of body fluids. In certain types of burns, blisters containing fluid are made, imagine the water loss of a patient who has such blisters over 60 percent of his body. In more severe burns where the skin is actually burned, the loss of body fluids is more noticeable. In cases of very severe burns, fluids actually seep out of the burned skin directly onto the patient’s bedding. Along with these fluids, electrolytes are also lost. Thus, this severely injured person must face both fluid and electrolyte losses.

FRAME 50

Several other abnormal means of losing fluids and electrolytes also exist. These abnormal ways are the subtle ways of losing large volumes of fluids and large numbers of electrolytes. One subtle means of abnormal fluid loss is by gastric suction. The Gomco® Pump can be used to remove gastric juices from a patient's stomach. Often, a nurse will give the patient small amounts of water to relieve thirst. When this occurs, the gastric fluid, the water, and large numbers of electrolytes are withdrawn from the stomach. Before long, the patient has lost a tremendous number of electrolytes. Bleeding also produces a loss of fluid (plasma), blood cells, and other important substances. Lastly, a person who is being treated with a thiazide diuretic also loses fluids and electrolytes (primarily potassium). In such cases, potassium must be given to the patient in order to prevent potassium deficiencies.

FRAME 51

QUESTION: List five abnormal ways fluid can be lost from the body.

a. _____.

b. _____.

c. _____.

d. _____.

e. _____.

FRAME 52

In the earlier sections of this module, the concepts of body fluid distribution, electrolyte distribution, and fluid and electrolyte loss by both normal and abnormal means were discussed. A certain volume of fluid will be lost from the body each day and this fluid will contain electrolytes. The fluids and electrolytes lost each day must be replaced in order to maintain proper physiological functioning. If abnormal losses of fluids and electrolytes occur, these losses must be corrected. Two main ways of maintaining fluid and electrolyte balance and replacing abnormal fluid and electrolyte losses are available to the physician. These two methods of maintenance and replacement are through the oral (by mouth) route and by the intravenous route.

Solution to Frame 51

ANSWER: (Any 5 of the following)

Diarreha.
Vomiting.
Excessive perspiration.
Gastric suction.
Bleeding.
Burns.
Diueretics.

FRAME 53

The oral route of administration offers the safest and easiest method of replacing fluids and electrolytes. For example, a patient being treated with a thiazide diuretic can be given orange juice to replace the potassium that is being lost in the urine. Orange juice contains approximately 15 milliequivalents of potassium in each eight fluid ounces. Also available are effervescent tablets containing potassium. These tablets are supplied in several palatable flavors. When the oral route is used, the patient is able to move about freely and the psychological impact of intravenous administration is not present.

FRAME 54

The second major route used to administer fluids and electrolytes is by the intravenous route. The intravenous route makes it possible to control the volume of fluid and the numbers of each electrolyte to be given. One problem inherent in the intravenous administration of fluids is that frequently the patient is immobilized, it is very difficult to maneuver with all the intravenous apparatus hanging from one's arm.

FRAME 55

There are several other considerations concerning intravenous therapy. First, and extremely important, is the topic of infection. If microorganisms enter the patient through a contaminated intravenous solution, administration set, or administration site, potential problems could result. Remember, the patient who is receiving intravenous solution frequently is the patient least able to ward off an infection.

FRAME 56

Another consideration of intravenous therapy is the total volume of fluid to be administered to the patient over a given period of time. As a general rule, an adult patient should be administered a maximum of four liters (4,000 milliliters) of intravenous fluid per 24 hours. Of course, the volume of fluid to be administered would depend upon such factors as body weight, age, etc. Pediatric patients would be administered proportionally lower volumes of fluid. At first though, only the major fluids being administered to the patient would seem to apply. However, every milliliter of solution (to include “piggy-back”, hyperalimentation, and "to-keep-open" solutions) must be taken into account when calculating the volume of fluid that is being administered to the patient.

FRAME 57

The renal condition of the patient also influences the volume of intravenous solution to be administered. In circumstances where the patient is suffering from insufficient kidney function, the volume of administered fluid would have to be decreased to preclude fluid overload.

FRAME 58

Infection, volume of intravenous fluid to be administered, and the renal condition of the patient are all considerations involved in the intravenous administration of drugs. Bearing these considerations in mind, answer the following questions.

FRAME 59

QUESTION: A patient who has undergone three days of intravenous therapy has shown the signs of an infection. You believe the infection has resulted from the intravenous therapy. State three possible sources of the responsible microorganisms based upon your suspicions.

a. _____.

b. _____.

c. _____.

FRAME 60

QUESTION: A patient has been administered 2,500 ml of a hyperalimentation solution, one gram of an antibiotic administered piggyback in 300 ml of intravenous solution, and 800 ml of Lactated Ringer's solution during a 24-hour period of time. Was this patient administered too much intravenous fluid during this 24-hour period?

a. Yes.

b. It depends.

c. No.

Solution to Frame 59

ANSWER:

The intravenous solutions.

The adminisration sets.

The administration site.

FRAME 61

A fourth consideration of intravenous therapy is the tonicity of the intravenous solution being administered. In your previous pharmacy related courses, you were exposed to the concept of osmotic pressure and tonicity. In brief, solutions are classified into three broad categories based upon tonicity, isotonic, hypotonic, and hypertonic.

Solution to Frame 60

ANSWER: It depends. The age, size, and renal condition of the patient have been omitted on purpose. Without these bits of information, a definite answer cannot be given.

FRAME 62

To begin, an isotonic solution has the same concentration as that of body fluids. Below is a diagrammatic representation of the response a cell exhibits when placed in an isotonic solution:

FRAME 63

Observe that when a cell is placed in an isotonic solution no noticeable change in size occurs. Therefore, no cell irritation (related to the tonicity of the solution) would occur. Examples of isotonic solutions are 0.9% Sodium Chloride Solution and Lactated Ringer's Injection.

FRAME 64

A hypertonic solution is more concentrated than that of body fluids. Saying it another way, the hypertonic solution has more solute present per volume than does cell fluid. Therefore:

FRAME 65

Observe that fluid was “drawn” from the cell in order to achieve equilibrium. Therefore, the cell was reduced in size. Such an experience is traumatic for the cell unfortunate enough to be placed in such a situation. In relation to intravenous fluids, a hypertonic solution would cause cell irritation to blood cells and the cells lining the circulatory system. The patient who is being administered a hypertonic solution would experience localized pain in the area of the administration site. Examples of hypertonic solutions are most hyperalimentation solutions and 10% dextrose solution.

FRAME 66

A hypotonic solution is less concentrated than that of body fluids. That is, the hypotonic solution has less solute per volume than that of body fluid. When placed in a hypotonic solution, a cell will increase in size because water will enter the cell in an attempt to equalize the concentrations of the cell and the hypotonic solution:

FRAME 67

As you can see, unfortunate cells exposed to hypotonic solutions could become irritated and damage to them could result. Examples of hypotonic solutions are 0.45% sodium chloride solution and sterile water for injection.

FRAME 68

A final consideration in intravenous therapy is the pH of the solution to be administered to the patient. Solutions with an alkaline (pH greater than 7.0) or an acidic (pH less than 7.0) pH value have been associated with irritation of the veins (thrombophlebitis). In order to reduce the incidence of thrombophlebitis, buffering agents can be added to solutions with highly acidic or alkaline pH values in order to bring the pH of these solutions closer to pH 7.4, the approximate pH of blood. However, the alteration of some intravenous solutions' pH values can affect their stability as well as the stability of drugs added to those solutions. Consequently, appropriate pharmaceutical references must be consulted prior to adding buffering solutions.

FRAME 69

Below are the pH ranges for various intravenous solutions:

0.9 Sodium Chloride Solution	5.7 (Abbott) 5.5 (Baxter) 5.0 (Travenol)
Lactated Ringer's Injection	6.7 (Abbott) 6.5 (Baxter) 6.6 (Cutter)
Dextrose 5% in Water	pH range of solutions are from 4.0 to 5.0.

FRAME 70

Two considerations of intravenous therapy have just been discussed. These two considerations, the tonicity and the pH of infused fluids, are pertinent topics when discussing the preparation and the administration of intravenous fluids.

FRAME 71

QUESTION: Briefly state the effect of the intravenous administration of isotonic, hypertonic, and hypotonic solutions on a patient's veins.

a. Isotonic solution-_____.

b. Hypertonic solution-_____.

c. Hypotonic solution-_____.

FRAME 72

QUESTION: The administration of an acidic or an alkaline intravenous solution can irritate the patient's veins. What is this occurrence called?

_____

Solution to Frame 71

ANSWER:
a. Isotonic solution-no significant effect.
b. Hypertonic solution-can cause irritation to vein.
c. Hypotonic solution- can cause irritation to vein.

FRAME 73

QUESTION: Is the addition of a buffering agent to an intravenous solution always desirable? _____

Explain. _____

_____

Solution to Frame 72

ANSWER: Thrombophlebitis.

FRAME 74

The pros and cons of intravenous therapy have been discussed. Many formulations of intravenous solutions can be obtained. These formulations can be categorized into two main areas in regard to intended therapeutic use. These two broad therapeutic categories are maintenance and replacement.

Solution to Frame 73

ANSWER: No. Alteration of a solution's pH can affect its stability and the stability of drugs that are added to it.

FRAME 75

Maintenance therapy is designed to meet the ordinary fluid and electrolyte requirements of patients who have a restricted oral intake, but who are without extra losses caused by vomiting, diarrhea, or other stress. In short, maintenance therapy is designed to replace the fluids and electrolytes lost during a normal day.

FRAME 76

Few solutions can be used alone as maintenance solutions because the body requires a specified number of certain electrolytes each day. Most solutions contain only a limited number of electrolytes. For example, 0.9% Sodium Chloride Solution contains 154 mEq of sodium and 154 mEq of chloride in each 1,000 milliliters. 5% Dextrose Solution contains approximately 170 calories per liter of solution. Observe that the sodium chloride solution contains only sodium and chloride ions, while the dextrose solution contains absolutely no electrolytes. Lactated Ringer's injection contains 130 mEq of sodium, 109 mEq of chloride, 3 mEq of calcium, *28* mEq of lactate, and 4 mEq of potassium in each liter of the solution. Although more electrolytes are contained in the Lactated Ringer's injection, the amount of each electrolyte supplied is usually below that amount the patient needs each day.

FRAME 77

The second broad therapeutic category of intravenous therapy involving fluids and electrolytes is referred to as replacement. Replacement therapy is designed to help patients with pre-existing or continuing fluid and electrolyte losses requiring replacement of extracellular fluid. Solutions used for replacement therapy should be tailored to fill the needs of the patient. For example, a patient who has had severe diarrhea for three days would have different fluid and electrolyte requirements than a patient who has suffered from severe vomiting for three days. Laboratory tests can be used to gain an idea of the electrolytes and the numbers of each electrolyte that need to be replaced. Once laboratory results are obtained, a solution can be prepared to replace depleted fluids and electrolytes. A solution such as 5% dextrose solution can be used as a parent solution for such a preparation.

FRAME 78

Remember, in cases where deficiencies in fluids and electrolytes exist, fluid and electrolyte maintenance and replacement therapy must be instituted in most cases.

FRAME 79

Two broad therapeutic uses of intravenous solutions in regard to fluid and electrolyte therapy are referred to as maintenance and replacement.

FRAME 80

QUESTION: What is the difference between maintenance and replacement therapy in reference to fluid and electrolyte therapy?

_____

_____

_____

_____

_____

_____

_____

_____

FRAME 81

This completes Section I. Go on to Section II.

Solution to Frame 80

ANSWER: Maintenance therapy is used to replace fluids and electrolytes that are lost during the course of a normal day. Replacement therapy seeks to replace those fluids and electrolytes that are lost due to extraordinary losses of these essential substances.

Section II. PRECAUTIONS AND COMPLICATIONS ASSOCIATED WITH INTRAVENOUS THERAPY

5-1. INTRODUCTION

Normally, a person obtains the fluids and electrolytes needed to live by the oral route. This route has certain built-in safeguards against bacterial invasion. When the intravenous route of administration must be used, the material being given is injected directly into the circulatory system through the veins. Although this route of administration is certainly effective in terms of getting the fluid into the patient, the intravenous route is not completely safe. Complications (e.g., infection) can arise. In the case of infection, the fluid being administered, the intravenous administration set (the equipment between the bottle or the bag and the patient), or the technique used to start the fluid administration are potential sources of bacterial contamination. In short, the intravenous administration of fluids is to be taken seriously.

5-2. TWO BASIC CATEGORIES OF INTRAVENOUS PREPARATIONS

We have all seen intravenous solutions being administered to a patient. We have known that the bottle or bag connected to the patient by a plastic tube means life to many patients. For the purpose of discussion, this subcourse divided intravenous preparations into two major categories: intravenous solutions and intravenous admixtures. The purpose of this division is to help you understand that the pharmacy does not prepare every intravenous product which is administered to a patient.

a. **Intravenous Solutions.** Intravenous solutions are products which meet certain rigid requirements and are supplied ready for use by manufacturers. Examples of such intravenous solutions are 5% Dextrose Injection, 0.9% Sodium Chloride Injection, and Lactated Ringer's Injection. These solutions are ready for use as soon as they arrive from the manufacturer. You will see the 5% Dextrose Injection and the 0.9% Sodium Chloride Injection used as "to keep open" (TKO) solutions. That is, they are slowly administered to a patient in order to provide fluid. In addition, they serve as a ready and rapid way by which drugs could be given to the patient should the patient go into shock. These solutions serve as a "base" for the category below.

b. **Intravenous Admixtures.** Intravenous admixtures are intravenous solutions to which have been added one or more drugs. For example, it is common for a patient to be administered a liter of 5% Dextrose Injection which has 20 mEq of potassium chloride added to it. Thus, the patient received fluid, nutrients (dextrose), and electrolytes (potassium and chloride). Typically, patients receive much more complicated intravenous admixtures. These intravenous admixtures are prepared in the Pharmacy Sterile Products Section by specially trained persons who use aseptic techniques.

5-3. REQUIREMENTS FOR INTRAVENOUS SOLUTIONS/INTRAVENOUS ADMIXTURES

Any solution administered through a patient's veins must be:

a. **Sterile.** Sterile means that no living microorganisms are present in the solution.

b. **Pyrogen-Free.** Pyrogens are substances which produce fever when injected into the circulatory system.

c. **Free from Visible Particulate Matter.** Visible particles in an intravenous preparation mean that the product should be discarded. These particles could have been present in the solution when it arrived in the pharmacy or they may have been accidentally added to the solution when other substances were added. Regardless of origin, these visible particles, if intravenously administered, could cause a blockage in the patient's circulatory system. Filters with very small pores are available which can remove these visible particles as the product is being administered. But remember, the origin of the particles is unknown--it is possible that some particles could be undissolved drug. Removing the drug particles would be good, but the patient should receive the prescribed amount of medication to achieve the desired therapeutic effect.

5-4. PRECAUTIONS PERTAINING TO FLUID THERAPY

You could be in the position of seeing that an intravenous solution prepared for a patient does not do more harm than good. If you have received special training in the preparation of intravenous solutions in the Pharmacy Sterile Products Section, you are well familiar with the tasks you must perform In order to insure the patient receives what is intended in an intravenous product. Below are some of the precautions which are of primary importance in protecting the welfare of a patient who is on intravenous therapy.

a. **Contamination.** A solution intravenously administered to a patient must be free from living microorganisms. Microorganisms are capable of entering the admixture when it is prepared. Therefore, the person who prepares the admixture in the Pharmacy Sterile Products Section has the great responsibility of using aseptic technique. When there is doubt about the sterility of the admixture (or intravenous solution), the product should be discarded. Microorganisms are also present in the environment of the hospital room. They are on the hands of the person who will start (i.e., begin the administration) the intravenous product. Therefore, this person is responsible for using care and aseptic technique to make the venipuncture.

b. **Incompatibilities.**

(1) Certain drugs or chemicals react when they are placed in a solution. The result is changed drugs or chemicals. This same type of chemical change can occur when a drug is added to an intravenous solution. Remember the chemical reaction below?

$$AgNO_3 + NaCl \rightarrow AgCl (\downarrow) + NaNO_3$$

(2) In the laboratory, silver nitrate ($AgNO_3$) is added to sodium chloride (NaCl) and white precipate (silver chloride, AgCl) is formed. You can actually see the silver chloride formed. Unfortunately, one cannot see all the chemical reactions which could happen when a drug is added to an intravenous solution. But remember, when this type of reaction occurs, the patient is not receiving the drug(s) the physician ordered. How can such incompatibilities be prevented? The answer is simple, the person who prepares the admixture in the Pharmacy Sterile Products Section must use the references available there to determine if a drug (or combination of drugs) may be safely added to an intravenous solution. Furthermore, nursing personnel should be cautioned never to add a drug to the contents of the intravenous product without checking with the person in the Pharmacy Sterile Products Section.

c. **Irritating Drugs.** The veins are very sensitive. Therefore, any intravenous product which has an extreme pH or which is very concentrated can irritate the veins. In some cases, the physician can decide to place the drug in another intravenous solution with a resultant pH which will not irritate the veins to a great degree. In other cases, the site through which the irritating solution is being administered can be changed on a frequent basis in order to allow that part of the vein to recover.

d. **Particulate Matter.** Hold a bottle or bag of intravenous solution up in front of a light. See how it is sparkling clear. Actually, small particles called particulate matter are present in the solution. Standards allow for extremely small particles to be present in the solution in certain concentrations. Intravenous solutions or admixtures should never be administered to a patient when the products contain visible particulate matter. A product which is cloudy in nature might actually be cloudy because of suspended particulate matter. Remember, filters are available which can filter most particulate matter from intravenous products, but in some cases the particulate matter is actually drug particles.

5-5. COMPLICATIONS OF INTRAVENOUS FLUID THERAPY

Various complications are associated with the administration of intravenous fluid therapy. Some of these complications are:

a. **Infection.** When microorganisms enter the circulatory system through the venipuncture site, an infection can result. The microorganisms--primarily bacteria--can be present in the intravenous solution or admixture, in the intravenous administration

set, or around the administration site when the product is administered. The infection can be localized or systemic.

b. **Infiltration.** Infiltration occurs when the needle or catheter through which the product is entering the veins is removed from the vein. In this case the fluid enters the tissue surrounding the vein. Although this condition is not usually serious, it can be very uncomfortable for the patient. To remedy this problem, the product is started in another administration site.

c. **Phlebitis.** Phlebitis is the inflammation of vein tissue. Phlebitis is caused by mechanical, chemical, or bacterial irritation. This condition is characterized by pain and redness at the administration site. When phlebitis occurs, the solution is usually administered at a different site.

d. **Pyrogenic Reaction.** A pyrogenic reaction is one in which the patient's body temperature increases after certain types of substances enter the circulatory system. Bacteria (or their parts), various chemicals, and certain types of particles are capable of causing a pyrogenic reaction. A pyrogenic reaction is characterized by chills followed by a fever.

e. **Circulatory Overload.** The "average" person has a blood volume of approximately five liters. Blood is approximately 93 percent fluid. The body has intricate mechanisms for compensating with changes in blood volume. For example, when you give blood, some fluid from the inside of the cells as well as fluid surrounding the cells enters the circulating blood volume. Likewise, there is a reverse flow when the blood volume is normal and intravenous fluids are administered. Unfortunately, when too much fluid is administered too rapidly circulatory overload can result. When circulatory overload occurs, the heart cannot efficiently pump the blood. Circulatory overload is a potentially dangerous condition which must be treated by the physician.

f. **Air Embolism.** An air embolism occurs when a sizeable volume of air enters the circulatory system. An air embolism can be caused by the movement of air through the intravenous administration set into the circulatory system. This can occur when the intravenous administration set has not been properly "bled" (i.e., had all the air replaced by intravenous solution) or by an intravenous solution or admixture bottle which has been allowed to empty completely resulting in air flow down the administration set. An air embolism is potentially dangerous because an air bubble can occlude cardiac, cerebral, or pulmonary circulation.

g. **Thrombus.** A thrombus is a clot which is formed in the blood vessels. A thrombus is usually a further complication of phlebitis. A clot formed in the vessels can produce damage to tissue below the stoppage.

Section III. CATEGORIES OF INTRAVENOUS FLUIDS AND THEIR USES

5-6. INTRODUCTION

Many patients in hospitals receive intravenous fluid therapy. The reasons for their receiving intravenous fluid therapy are not the same. Likewise, the solutions they receive are not all alike. Some patients have intravenous solutions tailored to meet their specific fluid, nutritional, and electrolyte needs. This section of the subcourse will focus on those solutions commonly used and/or prepared in the hospital setting.

5-7. HYDRATING SOLUTIONS

a. **Use.** Hydrating solutions are used to provide the patient with required fluid (i.e., water). The volume of preparation administered depends on the fluid needs of the patient.

b. **Examples of Hydrating Solutions.** Below are some examples of preparations commonly used as hydrating solutions.

(1) 5% Dextrose Injection (D5W). This solution consists of dextrose and water. One liter of the 5% Dextrose Injection contains approximately 170 calories. This solution contains no appreciable electrolytes. Therefore, electrolytes are sometimes added to the 5% Dextrose Injection (e.g., 15 mEq KCl in one liter of D5W). The 5% Dextrose Injection is used to provide fluid replacement and energy.

NOTE: Dextrose solution is available in several concentrations. For example, you will see 10% Dextrose Injection and 50% Dextrose Injection in the pharmacy. Because of its high concentration, 50% Dextrose Injection should never be injected before it is diluted.

(2) 0.9% Sodium Chloride Injection (Normal Saline). This product is a solution of sodium chloride and water. Each 100 milliliters of solution contains 0.9 gram of sodium chloride. 0.9% Sodium Chloride Injection contains 154 milliequivalents of sodium and 154 milliequivalents of chloride in each 1,000 milliliters of solution. This product is used to provide fluid replacement and to replace moderate losses of the sodium ion (Na^+).

NOTE: Sodium chloride solutions are also available in other concentrations. For example, 0.45% Sodium Chloride Injection is commonly seen.

(3) 5% Dextrose Injection in 0.9% Sodium Chloride Injection. This product has in each 100 milliliters five grams of dextrose and 0.9 grams of sodium chloride. As you might think, it is a combination of products "a" and “b” above. Not only does this product provide a source of fluid, it also serves as a source of both energy (170 calories/liter) and sodium. This product is used in fluid replacement, in the replacement of moderate losses of sodium, and as a source of energy.

NOTE: Various combinations of dextrose and sodium chloride are available. For example, 5% Dextrose in 0.45% Sodium Chloride Injection, and 2.5% Dextrose in 0.9% Sodium Chloride Injection.

5-8. ELECTROLYTE REPLACEMENT SOLUTIONS

a. **Use.** Electrolyte replacement solutions provide both electrolytes (like sodium, potassium, etc.) and fluid to the patient. Special electrolyte replacement solutions can be prepared in order to meet the needs of particular patients.

b. **Examples of Electrolyte Replacement Solutions.** Below are only two of the solutions commonly used to replace electrolytes.

(1) Lactated Ringer's Injection (LR. Ringer's Lactate, RL, Hartmann's Solution). This product is a solution of electrolytes in water. This product contains sodium, potassium, calcium, chloride, and lactate ions. The lactate ion in the product has an alkalizing effect and is metabolized in the liver to glycogen and ends up as carbon dioxide and water. Lactated Ringer's Injection is used as a fluid replacement and as an electrolyte replacement.

(2) Lactated Ringer's Injection with 5% Dextrose (D5RL). This product is a combination of Lactated Ringer's Injection and 5% Dextrose Injection. The dextrose supplies 170 calories per 1,000 milliliters of solution. D5RL is used as a fluid replacement, electrolyte replacement, and as a source of energy.

NOTE: Other combination products are available.

5-9. PLASMA EXPANDERS

a. **Use.** Plasma expanders are used to treat or prevent acute and severe fluid loss due to trauma or surgery. These products are usually used instead of whole blood in emergency situations in which whole blood is not available.

b. **Examples of Plasma Expanders.**

(1) Normal human serum albumin. Normal human serum albumin is a fraction of whole blood. It is a clear, moderately viscous, brownish fluid which contains 25 grams of serum albumin in 100 milliliters of product. Because each gram of albumin holds approximately 18 milliliters of water, it is used as blood volume expander in the treatment of hemorrhage or shock. In this use, the albumin draws fluid into the circulatory system from the surrounding tissues. This product has also been used as a protein replacement in cases where the level of protein in the serum is very low (e.g., in nephrosis). Normal human serum albumin should not be given to dehydrated patients since it draws fluid from the body tissues. If necessary, the product may be administered to dehydrated patients if 0.9% Sodium Chloride Injection or 5% Dextrose

Injection is administered at the same time. Fortunately, this product is very stable. Therefore, it is not necessary to keep it refrigerated in its liquid state.

(2) Plasma protein fraction (Plasmanate). Plasma protein fraction is a sterile solution of stabilized human plasma proteins in 0.9% Sodium Chloride Injection. Each 100 milliliters of this product contains approximately five grams of protein. This product is nearly colorless (slightly brown). Plasma protein fraction is used in the treatment of nonhemorrhagic shock (i.e., shock not associated with loss of whole blood). Side effects associated with this product are uncommon, but they include increased salivation, nausea, and vomiting.

5-10. NUTRIENT SOLUTIONS (HYPERALIMENTATION PRODUCTS)

These products provide total parenteral nutrition for those patients who cannot, should not, or will not ingest the nutrients they need to live. It should be noted that a hyperalimentation can supply all the patient's nutritional needs by administration through the circulatory system. However, these solutions are quite expensive and, because of their nutrient content, are highly susceptible to bacterial growth. Most of the solutions contain high concentrations of carbohydrates (e.g., dextrose). Because of this high concentration, the solutions must be administered through a large-bore vein. Just placing the needle or catheter into such a large-bore vein is a surgical procedure in itself. The hyperalimentation solution is prepared in the Pharmacy Sterile Products Section by a specially trained person. Extreme care must be taken to prevent microbial contamination. The preparation of the product itself is quite a task because the preparer must add ingredients in a certain sequence since many of the components of a hyperalimentation solution are incompatible in certain concentrations. The components of most hyperalimentation solutions are water, dextrose, amino acids, electrolytes, and vitamins. One product, Intralipid®, is an oil in water emulsion. Intralipid® is one hyperalimentation product which can be administered through a small-bore vein such as those found in the arm.

Continue with Exercises

EXERCISES, LESSON 5

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. An intravenous admixture is best described as an intravenous:

   a. Product which is at least 1,000 milliliters in volume.

   b. Solution which has one or more drugs added to it.

   c. Solution which contains only water and a high concentration of glucose.

   d. Product which is not prepared in the pharmacy.

2. Which of the following statements best describes a precaution pertaining to intravenous fluid therapy?

   a. All intravenous solutions must be visually checked for the presence of bacteria before the solution is administered.

   b. An intravenous product with visible particulate matter can be administered to a patient if the product is filtered immediately prior to administration.

   c. Two chemicals which are known to be incompatible can be mixed in an intravenous solution as long as no visible particulate matter is observed.

   d. Some intravenous solutions, because of their pH or concentration, may cause irritation to the vein in which they are administered.

3. Select the possible complication associated with intravenous fluid therapy.

   a. Dehydration.

   b. Phlebitis.

   c. Nausea and vomiting.

   d. Cardiac arrest.

4. Hyperalimentation products can be best described as products that:

   a. Provide the patient with only protein and fluid needs.

   b. Provide total parenteral nutrition for those patients who cannot, should not, or will not ingest the nutrients they need to live.

   c. Are designed to provide severely burned patients with the substances required for life for a short period.

   d. Contain fluids and trace amounts of proteins and fat.

5. Normal human serum albumin is classified as a(n):

   a. Plasma expander solution.

   b. Electrolyte replacement solution.

   c. Hydrating solution.

   d. Hyperalimentation solution.

6. Five percent Dextrose Injection in 0.9% Sodium Chloride Injection is classified as a(n):

   a. Plasma expander solution.

   b. Electrolyte replacement solution.

   c. Hydrating solution.

   d. Hyperalimentation solution.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 5

1. b (para 5-2b)
2. d (para 5-4c)
3. b (para 5-5a)
4. b. (para 5-10)
5. a (para 5-9b(1))
6. c (para 5-7b(3))

End of Lesson 5

LESSON ASSIGNMENT

LESSON 6 Review of the Endocrine System.

LESSON ASSIGNMENT Paragraphs 6-1 through 6-18.

LESSON OBJECTIVES After completing this lesson, you should be able to:

6-1. Given one of the following terms: gland, hormone, exocrine glands, endocrine glands, or negative feedback and a group of statements, select the statement that best defines the given term.

6-2. Given a list of the names of various glands or organs, select those that are endocrine glands.

6-3. Given a diagram of the body with the endocrine glands present and a list of the names of the endocrine gland, match each name with its appropriate location.

6-4. Given the name of an endocrine gland and a group of statements, select the statement that best describes the location or the function of that gland.

6-5. Given the name of an endocrine gland and a list of hormones, select the hormone(s) produced by that gland.

6-6. From a list of statements, select the statement(s) that best describe the physiological effects produced by a given endocrine hormone.

6-7. Given the name of an endocrine hormone and a group of statements, select the statement that best describes the effects of too much or too little of that particular hormone in the body.

6-8. From a group of statements, select the statement that best describes the changes that occur during a female's menstrual cycle.

6-9. From a group of statements, select the statement that best describes the changes that occur in a female after fertilization of an ovum occurs.

6-10. From a group of statements, select the statement that best describes the changes that occur at menopause.

6-11. Given the name of a disorder that affects the human reproductive system and a group of statements, select the statement that best describes that disorder.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 6

REVIEW OF THE ENDOCRINE SYSTEM

Section I. INTRODUCTION

6-1. OVERVIEW

a. Many of the drugs you will dispense will directly affect one or more of the endocrine glands or will perform some function intended to be performed by one of the endocrine glands. As you review the endocrine system, be aware of the importance of this system to your daily life.

b. The endocrine system is an interconnected system of glands that produces substances known as hormones. These glands are not connected directly, but are nonetheless connected by the circulatory system. The hormones these glands produce have wide-ranging effects on the body. The production of the proper hormone in the proper amount at the proper time is absolutely essential for the maintenance of good health. An imbalance of one of these hormones causes widely varying effects upon the body.

6-2. BASIC DEFINITIONS

a. **Gland.** A gland is a secreting organ. The process of secretion includes the production of a chemical substance and the release of that substance into the blood or a body cavity.

b. **Hormone.** A hormone is a specific chemical substance that is produced in one organ (that is, endocrine gland) and transported by the blood to distant parts of the body. The hormones stimulate these various parts of the body to perform a function.

c. **Exocrine Glands.** The exocrine glands are duct glands. That is, exocrine glands secrete a chemical substance through a system of ducts into a body cavity or onto the body surface. Examples of exocrine glands are the liver, salivary glands, and sweat glands.

d. **Endocrine Glands.** Endocrine glands are ductless glands. That is, endocrine glands secrete hormones directly into the bloodstream instead of through a duct or duct system. Examples of endocrine glands include the pituitary body and the thyroid gland.

e. **Negative Feedback.** Negative feedback enables the endocrine glands to regulate themselves. Negative feedback means that once the normal physiological function of the hormones has been achieved, information is transmitted back to the glands in some way and the producing glands stops or slows the production of that particular hormone. The presence of increased amounts of a hormone will depress the endocrine gland responsible for the production of this hormone and cause less of this hormone to be produced. Conversely, a decrease in the blood levels of a hormone will cause the endocrine gland to produce more of this hormone.

6-3. GENERAL COMMENTS

a. **Control "Systems" of the Human Body.** The structure and function of the human body is controlled and organized by several different “systems.”

(1) Heredity/environment. The interaction of heredity and environment is the fundamental control “system.” Genes determine the range of potentiality and environment develops it. For example, good nutrition will allow a person to attain his full body height and weight within the limits of his genetic determination. Genetics is the study of heredity.

(2) Hormones. The hormones of the endocrine system serve to control the tissues and organs In general. (Vitamins have a similar role.) Both the hormones and vitamins are chemical substances required only in small amounts.

(3) Nervous system. More precise and immediate control of the structures of the body is carried out by the nervous system.

b. **The Endocrine System**. In the human body, the endocrine system consists of a number of ductless glands that produce their specific hormones. Because these hormones are carried to their target organs by the bloodstream, the endocrine glands are richly supplied with blood vessels.

c. **Better Known Endocrine Organs of Humans**. The better known endocrine glands are the:

(1) Pituitary body.

(2) Thyroid gland.

(3) Parathyroid glands.

(4) Pancreatic islets (Islets of Langerhans).

(5) Suprarenal (adrenal) glands.

(6) Gonads (ovaries in the female, testes in the male).

(7) In addition, there are several other endocrine glands whose function is less well understood and there are other organs that are suspected to be of the endocrine type. Figure 6-1 shows some of the better known endocrine glands and their locations.

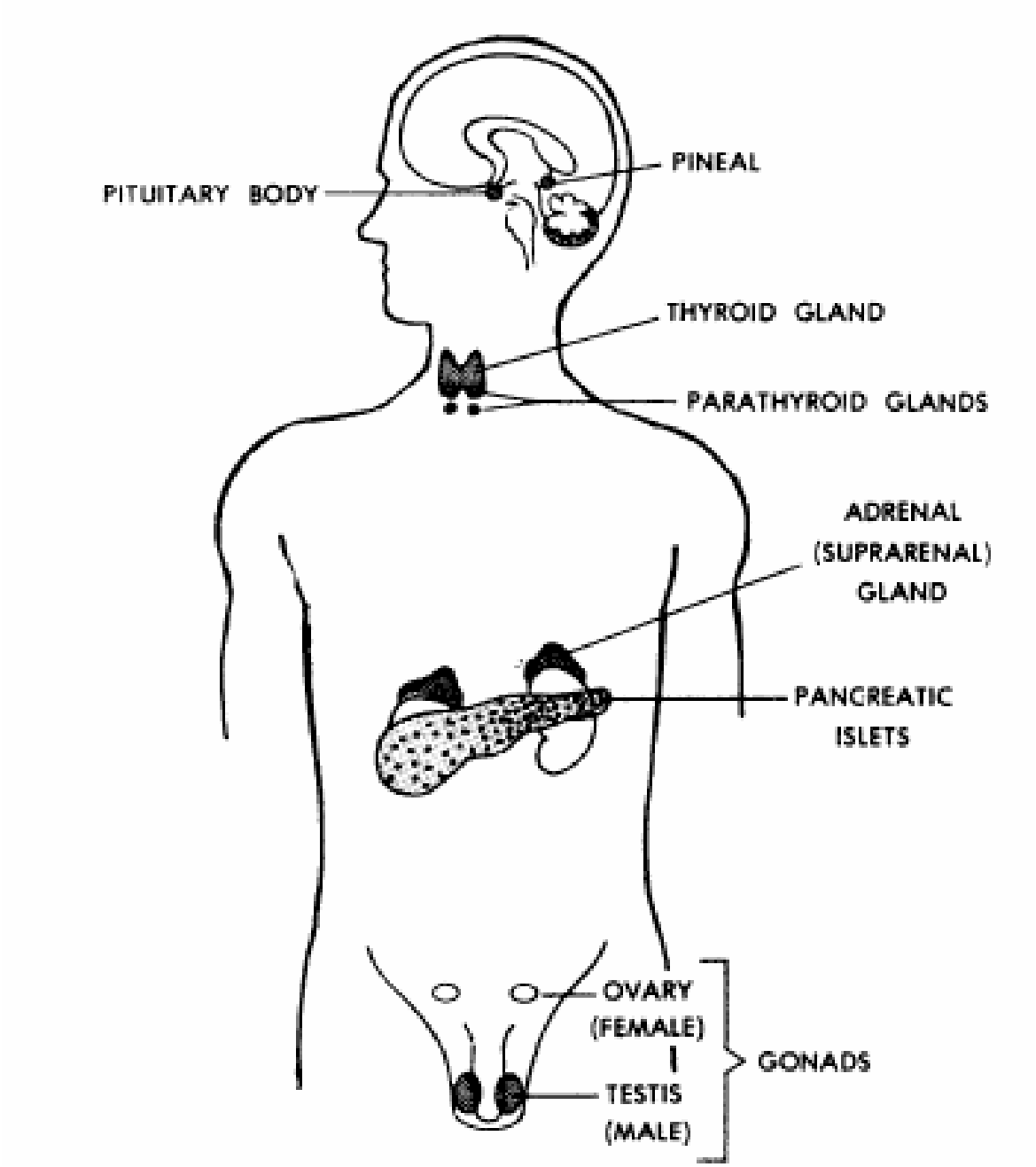


Figure 6-1. The endocrine glands of the human body and their locations.

Section II. ENDOCRINE GLANDS

6-4. INTRODUCTION

In order to gain an understanding of some of the drugs that will be presented later in the subcourse, you must become familiar with the endocrine glands and the functions they perform. As you read the paragraphs below, associate the gland with the substance(s) it produces and with the function(s) performed by the/those substance(s).

6-5. THE PITUITARY BODY

a. **Location.** The pituitary body is a small pea-sized and pea-shaped structure. It is attached to the base of the brain in the region of the hypothalamus. In addition, it is housed within a hollow of the bony floor of the cranial cavity. The hollow is called the sella trucica ("Turk's saddle"). This gland is sometimes referred to as the "master gland" of the body because of the many effects it produces.

b. **Major Subdivisions of the Pituitary Body.** The pituitary body is actually two glands, the posterior pituitary gland and the anterior pituitary gland. Initially separate, these glands join together during development of the embryo.

6-6. THE POSTERIOR PITUITARY GLAND

The posterior pituitary gland is the portion that comes from and retains a direct connection with the base of the brain. The hormones of the posterior pituitary gland are actually produced in the hypothalamus of the brain. From the hypothalamus, the hormones are delivered to the posterior pituitary gland where they are released into the bloodstream. At present, we recognize two hormones of the posterior pituitary gland.

a. **The Antidiuretic Hormone.** The Antidiuretic Hormone (ADH, Vasopressin) is involved with the resorption or salvaging of water within the kidneys. Therefore, this hormone produces its main effects in the kidneys. In the kidney, ADH increases the permeability of the distal tubules collecting tubules, thus causing the antidiuretic effect by osmosis. In large doses, vasopressin increases blood pressure by direct stimulation of the smooth muscles in the vessels. This effect is seen only with injections of vasopressin. Diabetes insipidus is a disorder that may be caused by hyposecretion of vasopressin. Diabetes insipidus is characterized by polyuria (excessive urine production). As much as 20 to 40 liters of urine may be excreted in one day by a patient who has diabetes insipidus. Polydipsia (excessive thirst) is another characteristic of diabetes insipidus.

b. **Oxytocin.** Oxytocin is a hormone concerned with contractions of smooth muscle in the uterus and with milk secretion. The contractions occur in the pregnant female. Milk secretion is an effect of oxytocin that occurs after the female has delivered the baby.

6-7. THE ANTERIOR PITUITARY GLAND

The anterior pituitary gland originates from the roof of the embryo's mouth. It then attaches itself to the posterior pituitary gland. The anterior pituitary gland is indirectly connected to the hypothalamus by means of a venous portal system. By "portal," we mean that the veins carry substances from the capillaries at one point to the capillaries at another point (hypothalamus to the anterior pituitary gland). In the hypothalamus, certain chemicals known as releasing factors are produced. These are carried by the portal system to the anterior pituitary gland. Here, they stimulate the cells of the anterior pituitary gland to secrete their specific hormones. The anterior pituitary gland produces many hormones. In general, these hormones stimulate the target organs to develop or produce their own products. This stimulating effect is referred to as tropic. Of the many hormones produced by the anterior pituitary gland, we will examine these:

a. **Somatotropic Hormone (Growth Hormone).**

(1) The target organs of this hormone are the growing structures of the body. This hormone influences such structures to grow. Growth is produced because cell division is increased--stimulating increased growth of all tissues capable of growing. This hormone produces an increased utilization of amino acids to produce proteins. It also causes a renal depression followed by accumulation of sodium chloride and water. Inhibition of carbohydrate utilization also occurs, producing hyperglycemia.

(2) Unfortunately, the anterior pituitary gland does not always function properly. For instance, the anterior pituitary gland may produce too much or too little somatotropin. The hyposecretion of somatotropin in childhood produces a condition known as pituitary dwarfism that results in a lack of physical development. A 20-year old person with this disease may have the same physical appearance as a 5-year old child. Conversely, the hypersecretion of somatotropin in childhood may cause giantism. This is distinguished by accelerated, undiminished growth. An extreme example of the results of this condition is a man who has grown to a height of eight feet, 6-1/2 inches and weighs 375 pounds. This same hypersecretion sometimes occurs in adulthood. This condition is called acromegaly. In acromegaly, there is no increase in the height of the person since the epiphyses of the long bones have been fused. However, the membraneous bones such as the facial bones become enlarged and the person gains coarse facial features. Other symptoms of acromegaly include enlarged hands, feet, and internal organs. Hyposecretion of somatotropin in the adult causes a condition known as Simmond's disease. This disease produces what appears to be advanced physical senility, although the patient may be quite young.

b. **Thyroid-Stimulating Hormone.** The thyroid-stimulating hormone (Thyrotropic Hormone, TSH). stimulates the growth of the thyroid gland. It thus promotes the growth of the thyroid gland as well as the production and secretion of the hormones made by the thyroid gland. The secretion of the thyroid-stimulating hormone as well as the thyroid hormones is controlled by a negative feedback mechanism. That

is, a high level of TSH causes an increase in the amount of thyroid hormones produced. Once the levels of the thyroid hormones reach a certain level in the bloodstream, the amount of TSH secreted is reduced and the secretion of the thyroid hormones is decreased.

c. **Pituitary Gonadotropic Hormones.** The pituitary gonadotropic hormones are three in number. These hormones control the development and function of the sex glands (gonads). However, these hormones have differing effects in the different sexes. Each of these hormones will be discussed below.

(1) Follicle-stimulating hormone. In the female, the follicle-stimulating hormone (FSH)acts in the ovary to stimulate the growth and maturation of the ovarian follicles that contain the ovum (egg). The FSH also stimulates the secretion of estrogen, a female hormone, by the ovaries. In the male, the FSH acts on structures called the seminiferous tubules in the testes to cause spermatogenesis (the production of sperm).

(2) Luteinizing hormone. In the female, luteinizing hormone (LH) acts to cause ovulation, the release of a mature egg from the ovary. In the male, LH is known as the interstitial cell-stimulating hormone (ICSH). The ICSH controls the production of testosterone, a male hormone, in the testes.

(3) Prolactin (luteotropic hormone). In the female, prolactin causes the secretion of milk from the fully developed mammary gland (breast) after the breast has been stimulated by progesterone and estrogen.

6-8. THE THYROID GLAND

The thyroid gland is located in the neck just below the larynx (voice box). The thyroid gland secretes the hormone thyroxin.

a. **Background.** Thyroxin is synthesized within the thyroid gland by the combination of several amino acids with four atoms of iodine. Once made, the hormone is stored in the thyroid gland in combination with a protein. This protein-hormone complex is called thyroglobulin. The hormone is released into the blood by breaking the bonds between thyroxin and the protein. The thyroxin is then released into the bloodstream. The release of the hormone is stimulated by the thyroid-stimulating hormone from the anterior pituitary gland.

b. **Effects of Thyroxin.** When thyroxin reaches the cells of the body, it stimulates them to use more oxygen. This increases the metabolic rate, or basal metabolism, of the body. Basal metabolism is defined as the amount of oxygen the body uses per unit of weight when the body is at rest. Thyroxin also functions to regulate the growth of organs; aid in mental development; aid in sexual development; and aid in the metabolism of water, electrolytes, proteins, glucose, and lipids. The Basal Metabolic Rate test may be used to measure the effect of thyroxin on the body.

The Protein Bound Iodine test may be used to measure the amount of thyroxin present in the blood.

c. **Diseases Involving the Thyroid Gland.** There are several diseases involving the thyroid gland.

(1) Goiter. Goiter is an abnormal enlargement of the thyroid gland producing a distinct swelling at the base of the neck just below the larynx ("Adam's Apple"). Simple goiters result from a dietary lack of iodine. This occurs most commonly in areas in which the soil is relatively free of iodine and where no seafood, material high in iodine content-is eaten. The thyroid gland, because of the lack of iodine, does not produce enough active thyroxin. Because of this lack of thyroxin, increased amounts of thyroid-stimulating hormone are produced, stimulating the thyroid and causing it to increase in size. Hence, a goiter (abnormal enlargement) is formed.

(2) Graves' disease. Another form of goiter is called Graves' Disease. Graves' Disease is the result of an overactivity of the thyroid (or hyperthyroidism). It is also called exophthalmic goiter because of the protruding eyeballs that are characteristic of the disease. Other symptoms associated with Graves' Disease include nervous tension, fatigue, fast and irregular heart beat, and eventually, congestive heart failure. The cause of Graves' disease is unknown. The result of Graves' disease is an enlarged and hyperactive thyroid gland. Graves' disease is treated by the use of antithyroid drugs and/or surgical removal of part of the thyroid gland. Many of the clinical signs and symptoms typical of Graves' Disease may also be seen in patients who take an overdose of a thyroid drug.

(3) Cretinism. Diseases involving thyroid underactivity may be seen in children and adults. Hyposecretion of thyroxin in the fetus or newborn produces a disease called cretinism. This lack of thyroxin causes retardation of skeletal and nervous system growth. Untreated, this hyposecretion of thyroxin in a newborn can result in a mentally retarded dwarf. If the disease is detected very early, the child can be given thyroxin replacement therapy so development can be normal. Lack of thyroxin in adults may produce myxedema. Characteristics of myxedema include edema, fatigue, lethargy, sensitivity to cold, and other degenerative changes. The disease reaches its peak of severity in a hypothermic coma, in which the patient goes into a coma and the body temperature decreases to between 80 to 90 degrees Fahrenheit.

6-9. THE PARATHYROID GLANDS

The parathyroid glands are usually four in number. They are embedded in the posterior portion of the thyroid. Their principal action is the production of parathormone.

a. **Parathormone.** Parathormone is a hormone that works in conjunction with another hormone, calcitonin, to regulate the calcium and phosphate in the body. The storehouse of calcium in the body is bone. That is, bone is being formed and reabsorbed at the same time. Parathormone acts on bone by increasing bone

reabsorption and increasing serum calcium. Parathormone also acts on the kidneys to increase calcium reabsorption and on the intestinal tract to increase the absorption of calcium. The net effect is an increase in serum calcium level.

b. **Diseases Involving the Parathyroid Glands.**

(1) Hypoparathyroidism. Hypoparathyroidism is a disease usually caused by inadvertent surgical removal of the parathyroid glands. This removal results in a lack of parathromone that decreases the serum calcium. Lowering the serum calcium level causes increased neuromuscular irritability that results in tetany. Tetany is characterized by intermittent muscular contractions, tremor, and muscular pain.

(2) Hyperparathyroidism. Occasionally, the parathyroid glands produce too much parathormone. This condition is called hyperparathyroidism. Hyperparathyroidism causes erosion of the skeletal muscle system. Such an erosion results in weak, painful, and brittle bones.

c. **Calcitonin**. Calcitonin apparently performs as a sort of fine control of the blood's calcium level. Its action is essentially the reverse of parathormone. Calcitonin causes the body to build more bone-thus decreasing the serum calcium level. Calcitonin is produced by both parathyroid and thyroid glands.

6-10. THE ADRENAL GLANDS

The adrenal glands (also known as suprarenal glands) are embedded in the fat above each kidney. Both adrenal glands have an internal medulla and an external cortex.

a. **Hormones of the Adrenal Medulla.** The medullary (inside the gland) portion of each adrenal gland produces a pair of hormones, epinephrine (adrenalin) and norepinephrine (noradrenalin). These hormones are both involved in the mobilization of energy during the stress reaction ("fight or flight" response). These hormones are also produced in the autonomic nervous system. Therefore, production of these hormones in the adrenal medulla is not necessary for life. After production, these hormones are stored in the adrenal medulla and are released in large quantities during the stress reaction.

(1) Epinephrine (adrenalin). Epinephrine has the following effects on the body, constriction of arterioles which produces a rise in blood pressure, increased heart rate and force of contraction, inhibition of intestinal activity, contraction of the gallbladder, dilation of the pupils, stimulation of glycogenolysis, stimulation of adrenocorticotropic hormone (ACTH) production, and bronchodilation.

(2) Norepinephrine (noradrenalin). Norepinephrine has less an effect on the gastrointestinal tract and a greater effect on blood pressure than does epinephrine. Norepinephrine has no effect on the bronchioles. Tumors of the adrenal medulla are

called pheochromocytomas. These tumors produce hypertension (either chronic or acute), elevation of basal metabolism, and glucosuria.

b**. Hormones of the Suprarenal Cortex (Outside Area).** Approximately 28 hormones are produced by the suprarenal cortex. These hormones are produced only in the suprarenal cortex and are essential to life. The hormones of the suprerenal cortex are of most importance during times of stress (like trauma and disease). The hormones produced here tend to keep body metabolism stable during such periods of stress. The hormones reduce fluid loss, stabilize blood glucose, reduce inflammation, and prevent shock. Animals that have had their adrenal glands removed die under much less stress than do animals that have their adrenal glands. Occasionally, the suprarenal cortex malfunctions. When its function is reduced, a condition called Addison's disease results. Fatigue, muscle weakness, weight loss, low blood pressure, gastronintestinal upset, and collapse are clinical signs of Addison's disease. When the suprarenal cortex too actively secretes its hormones, a condition called Cushing's disease results. Cushing's disease is characterized by the abnormal disposition of fat in the face (called moon face) and back of the neck (called buffalo hump), obesity, edema, hypertension, acne, abnormalities in carbohydrate metabolism (in 90 percent of patients), and diabetes mellitus (in 20 percent of patients). The hormones produced here can be grouped into two major categories according to their action. These two categories are the mineralocorticoids and the glucocorticoids.

(1) Mineralocorticoids. The mineralocorticoids affect the electrolytes and water in the body. These hormones cause a conservation of sodium (Na+) and chloride (Cl-) by increasing the renal reabsorption of these ions. Conversely, they increase the excretion of potassium (K+). This retention of sodium and chloride also causes a retention of water. The principle mineralocorticoid is aldosterone. Other hormones in this group also exhibit, to some degree, some glucocorticoid activity.

(2) Glucocorticoids. Glucocorticoids have several different metabolic effects. They cause deposition of glycogen in the liver, gluconeogenesis (conversion of amino acids to glucose), liberation of amino acids from proteins, mobilization of fats, decreased utilization of glucose, and an increase in blood glucose levels. Hydrocortisone is the principal example of a glucocorticoid. Hydrocortisone and cortisone both have sodium-retention effects. Both hydrocortisone and cortisone have anti-inflammatory actions and cause dissolution of lymphoid tissue. Synthetic steriods have more effect on inflammation than do naturally occurring steroids.

6-11. THE PANCREAS

The pancreas is located behind the stomach in the curve of the duodenum. The pancreas may be considered both an endocrine and an exocrine gland since pancreatic juices are secreted through the common pancreatic duct. Two types of tissue make up the pancreas. The acini secrete digestive juices into the duodenum. The Islets of Langerhans is the endocrine tissue. The Islets of Langerhans contains two types of

cells, each type produces a particular hormone. Alpha cells produce glucagon. Beta cells produce insulin, a hormone essential to the body's metabolism.

a. **Glucagon.** Glucagon is frequently called the hyperglycemic factor. Glucagon causes glycogenolysis (the conversion of glycogen into glucose) and tends to prevent hypoglycemia. Glucagon is released when blood glucose levels drop, thus, glucagon tends to raise the level of sugar in the blood.

b. **Insulin.** Insulin's principal effect is to increase the cells' permeability to glucose. When the glucose enters the cells, it is metabolized to produce energy. Insulin also increases glycogenesis in the liver, thus, it increases glycogen stored there. A hyposecretion of insulin is known as diabetes mellitus. There are essentially two types of diabetes, juvenile diabetes and maturity-onset diabetes. Juvenile diabetes develops early in life, usually about the time of puberty, and is frequently associated with ketoacidosis. This form of diabetes is treated with insulin therapy. Maturity-onset diabetes frequently does not appear until middle age. Maturity-onset diabetes is usually milder than juvenile diabetes. Furthermore, maturity-onset diabetes is sometimes managed by the administrating of oral hypoglycemics and by controlling the patient's weight and diet. The lack of insulin decreases the amount of glucose that enters the cells of the body and increases the amount of glucose present in the person's blood (hyperglycemia). Hyperglycemia causes sugar to spill over into the urine. This results in glycosuria and polyuria (due to the osmotic effect of the glucose). The lack of glucose entering the cells causes gluconeogenesis and fat catabolism. This result in wasting of the cells and ketoacidosis. Ketoacidosis leads to coma and death. Uncontrolled diabetes mellitus may be accompanied by hyperglycemia, glycosuria, polyuria, polydipsia (excessive thirst leading to increased water intake), ketoacidosis, wasting coma, and death. A person who has diabetes mellitus may be required to take insulin to treat the lack of insulin present in the body. If a person must take insulin, it is likely that this individual must take insulin for the remainder of his or her life. Remember, insulin taken by the diabetic does not cure diabetes. In the opposite fashion, an overdose of insulin may cause hypoglycemia, depression of the central nervous system, and death. One possible treatment of this condition is an injection of glucagon. Remember, when injected, glucagon causes glycogenesis that results in an elevated level of blood sugar.

6-12. THE GONADS

Both the male and female sexes have gonads. The female and male cells, or gametes, are produced by the reproductive glands or gonads. In the male, the gonads are the two testes. In the female, the gonads are the two ovaries. In addition to these primary sex glands, there are a number of accessory organs. In the male, these accessory organs are the vas deferens, seminal vesicles, prostate gland, and the penis. In the female, the accessory organs are the fallopian tubes (oviducts), uterus, vagina, and mammary glands. For a review of the human reproductive system, review Lesson 6 in MD0806, Pharmacology III.

a. **Male.** In the male, the actual reproductive cells are the spermatozoa (sperm). The spermatozoa are produced in the seminiferous tubules of the testes. In the testes, germinal cells produce spermatozoa by a process called spermatogenesis. Once formed, the spermatozoa travel into another portion of the testes called the epididymis. The spermatozoa are stored in the epididymis until they mature. From the epididymis, the spermatozoa travel in two ducts called the vas deferens. The vas deferens unite with the urethra. In the vas deferens, the spermatozoa are joined by a fluid produced by the seminal vesicle. This fluid, together with the secretions of the prostate gland and the bulbo-urethral gland which flow into the urethra, compose the semen that nourishes the spermatozoa and provides the electrolytes and proper pH In the proper concentration range. The vas deferens is separated from the urethra by the ejaculatory duct (a muscular sphincter). During the process of ejaculation, the sphincter relaxes and the spermatozoa are propelled by powerful peristaltic waves. At the onset of puberty in the male, the pituitary gland produces follicle-stimulating hormones (FSH) which stimulate the seminiferous tubules to undergo spermatogenesis and produce spermatozoa. At the same time, the pituitary gland releases interstitial cell-stimulating hormones (ISCH or LH), that stimulate the interstitial cells in the testes to produce androgens. Androgens are masculinizing hormones. The principal androgen is testosterone. Testosterone, in turn, stimulates the secondary sexual characteristics of the male. These androgens are produced throughout the male's life.

b. **Female.** In the female reproductive system, the ovaries produce the egg cell or ovum. The ovum then passes the short distance between the ovary and the fallopian tube (in the abdominal cavity) and enters the fallopian tube (oviduct). The ovum then travels down the oviduct by peristalsis and ciliary movement of the cells lining the oviduct. The fallopian tubes connect the ovaries with the uterus. The uterus is a pear-shaped organ in the center of the female reproductive system. It is lined with a tissue called the endometrium. The base of the uterus is a diaphragm-like structure called the cervix. Below the cervix is a muscular tube called the vagina.

(1) Hormone production. The production of hormones in the female is considerably more complex than in the male. The hormones of the female reproductive system do not remain at a constant level, as in the male, but are in a cyclic balance. Each cycle takes, on the average, 28 days. To understand this cycle properly, one should first consider the production of the ovum in more detail. The ovaries are composed of several hundred thousand ova. These are surrounded by granulosa cells. This combination is called a primary follicle. Under the influence of hormones, the follicle enlarges and begins to secrete a fluid that fills the cavity inside the follicle, creating an antrum (cavity) in the follicle. Numerous follicles enlarge at the same time until one follicle ruptures. The remaining follicles then return to their normal state. The ova, which is released then migrates through the abdominal cavity until it reaches the fallopian tube. The ovum then takes from three to seven days to reach the uterus. However, the ova must be fertilized within 24 hours after it is released. Thus, the ova must be fertilized while it is in the oviduct. Occasionally, more than one follicle ruptures at the same time and more than one ova are released. This is the chief cause of multiple births. Pituitary gonadotropins function in the process of releasing ova.

(2) Follicle growth. Growth of the primary follicle is initiated by the folliclestimulating hormone (FSH). The FSH causes a proliferation of the granulosa cells and the production of the fluid filling the antrum. The luteinizing hormone (LH) causes a further production of fluid that continues until the follicle bursts. The ovum is then expelled and the remainder of the follicle undergoes a transformation into a mass of yellow cells known as the corpus luteum.

(3) Release of FSH. The release of FSH by the adenohypohysis, in addition to causing the growth of the follicle, also causes the follicles to secrete one of the two female hormones--estrogen. Estrogen is the principal female hormone. Estrogen is a composite of several hormones called estradiol, estriol, and estrone. These three substances have slightly different molecular structures, but they produce the same activity in the body. Estrogens are responsible for the secondary sexual characteristics of the female. Estrogens also cause the lining of the uterus, the endometrium, to increase in thickness by about threefold. The corpus luteum, under the stimulation of the luteotropic hormone secreted by the pituitary gland, begins to secrete large amounts of estrogen and progesterone. Unless fertilization of the ova occurs, the corpus luteum persists for about two weeks, after which time it begins to degenerate. Progesterone is the other female hormone. Its principal effect is on the endometrium. Progesterone causes the endometrium to secrete a nutrient fluid to nourish the ovum under its implantation, to deposit fats and glycogen in the endometrium, and to increase the blood supply to the endometrium. Progesterone also prepares the breasts for the secretion of milk and inhibits contractions of the uterus, since contractions might expel the ovum. Thus, if fertilized, the ovum would be able to stay in the uterus.

6-13. THE FEMALE'S MENSTRUAL CYCLE

The rhythmical cycle of events in the female's reproductive system is known as the menstrual cycle. The menstrual cycle depends on the interplay of the hypophyseal gonadotropins and the estrogens. At the beginning of the cycle, estrogen levels are low. Because estrogens act to inhibit the pituitary's production of the follicle-stimulating hormone (FSH), the FSH level is allowed to increase. The increase in the FSH acts on the ovaries to stimulate the production of estrogens. The level of estrogens as produced by the follicles then increases, causing a drop in the FSH level. At midcycle, the luteinizing hormone (LH) is secreted by the pituitary gland. The luteinizing hormone stimulates ovulation, followed by the conversion of the follicle to a corpus luteum and the secretion of estrogen and progesterone by the corpus luteum. The high levels of progesterone cause a decrease in secretion of the luteinizing hormone. If the egg is not fertilized by a sperm cell, the corpus luteum degenerates, causing a drop in levels of both estrogen and progesterone that completes the cycle. This drop in estrogen and progesterone levels causes the endometrium to degenerate and slough off and also causes small hemorrhages in the uterus. This is the cause of the periodic menstrual flow in women.

6-14. CHANGES DUE TO FERTILIZATION OF THE OVUM

If the ovum is fertilized by a sperm cell, the menstrual cycle ceases. After the fertilized ovum passes through the fallopian tube, it implants into the already prepared endometrium. The embryo (fertilized egg) grows rapidly and soon develops a placenta. The placenta is a tissue that eventually covers about one-fourth of the uterus. The placenta is located between the endometrium and the fetus. The placenta is supplied with blood vessels from the mother and blood vessels from the embryo through the umbilical cord. There is no direct exchange of blood between the mother and the embryo; however, the embryo is able to receive nutrients, electrolytes, and oxygen from the mother's blood by the processes of diffusion and active transport. Likewise, waste products from the embryo's system are diffused from the embryo's blood to the mother's blood. The fetus is surrounded by its own membranes and is supported by the amniotic fluid in the amniotic sac filling the uterus. The endometrium and placenta are maintained by high levels of progesterone, which acts to cause an increase in the concentration of nutrients in the endometrium, reduce uterine contraction, and prepare the breasts for lactation. For about the first trimester of pregnancy, the progesterones are supplied by the corpus luteum. The corpus luteum, which normally degenerates after two weeks, is itself maintained by another hormone, chorionic gonadotropin, which is produced by the cells of the fetus (embryo) very soon after implantation. After the first trimester of pregnancy, the corpus luteum degenerates and the progesterone becomes produced by the placenta. If, at any time during this "change over" the progesterone level falls too low, the endometrium will degenerate causing a spontaneous abortion. The estrogens produced during pregnancy come from the same sources as do the progesterones. The estrogens function to enlarge the uterus and the breast.

6-15. MENOPAUSE

Women usually stop menstruating at about the age of 45. This is known as the menopause. At this time, nearly all the primary follicles in the ovaries have been released or have become involuted (returned to normal size). Since the primary follicles supply most of the body's estrogen, the cyclic increase and decrease of estrogens cannot occur. Thus, the menstrual cycle is ended. Some women experience various effects (for example, hot flashes, fatigue, anxiety, and irritability) because of the metabolic changes the body is undergoing because of the decreased production of estrogen. The physician may prescribe estrogen therapy to the woman during this time.

Section III. DISORDERS OF THE HUMAN REPRODUCTIVE SYSTEM

6-16. INTRODUCTION

There are numerous disorders of the human reproductive system that can occur. This section of the lesson will consider some of these disorders.

6-17. ECTOPIC PREGNANCY

An ectopic pregnancy occurs when a fertilized ovum implants in a location other than the uterus. The usual site of such an implantation in an ectopic pregnancy is the fallopian tube. When the fertilized egg becomes attached to a site other than the uterus, it invades the tissues to which it is implanted and it forms a placenta, amniotic sac, etc. The weakness of the placenta may allow bleeding, fetus necrosis (death), or the fetus may develop normally. If the fertilized ovum implants somewhere in the abdominal cavity severe damage may result to the organ against which it implants.

6-18. TOXEMIA OF PREGNANCY

Toxemia of pregnancy is a condition characterized by hypertension, edema, proteinuria, and other variable symptoms. In its more severe form, it is called eclampsia. In severe cases, lesions of the liver, kidney, and brain of the mother can result. These lesions may be caused by an anti-immune process in which antibodies attack these organs. Eclampsia may be severe enough to require termination of the pregnancy in order to save the mother.

Continue with Exercises

EXERCISES, LESSON 6

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Endocrine glands are best described as:

   a. Duct glands that secrete a chemical substance through a system of ducts into a body cavity or onto the surface of the body.

   b. Glands that secrete chemical substances through the lymphatic system of the body.

   c. Ductless glands which secrete their hormones directly into the bloodstream instead of through a duct or duct system.

   d. Glands that have no ducts, but are actively involved in the production of perspiration and stomach acid.

2. Which of the following are endocrine glands?

   a. Pituitary gland, parathyroid gland, and the gonads.

   b. Suprarenal (adrenal) glands, thyroid gland, and salivary glands.

   c. Thyroid gland, Islets of Langerhans, and sweat glands.

   d. Pancreas, pituitary gland, and gallbladder.

3. The principle function of the parathyroid glands is the production of :

   a. Calcitonin.

   b. Parathormone.

   c. Thyroxin.

   d. Prolactin.

4. Select the hormone(s) produced by the suprarenal cortex.

    a. Glucagon and noradrenalin.

    b. Hydrocortisone and cortisone.

    c. Interstitial cell-stimulating hormone and estrogen.

    d. Testosterone and calcitonin.

5. Select the hormone(s) produced by the alpha cells of the Islets of Langerhans.

    a. Insulin.

    b. Hydrocortisone.

    c. Parathormone.

    d. Glucagon.

6. From the statements below, select the statement that best describes the physiological effect produced by testosterone.

    a. Testosterone stimulates the secondary sexual characteristics of the male.

    b. Testosterone stimulates the seminal vesicle to undergo spermatogenesis and to produce spermatozoa.

    c. Testosterone stimulates the pineal gland to produce the folliclestimulating hormone (FSH).

    d. Testosterone stimulates the process of glycogenolysis.

7. Addison’s disease, a condition caused by reduced functioning of the suprarenal cortex, is characterized by:

    a. Moon face and buffalo hump.

    b. Hyperglycemia and ketoacidosis.

    c. Fatigue, muscle weakness, and weight loss.

    d. The early onset of secondary male sexual characteristics.

8. Which of the statements below best describes the changes that occur during a female's menstrual cycle?

    a. The secretion of estrogen directly influences the production of progesterone that causes the endometrium to degenerate and slough off.

    b. A deficiency of estrogen caused by the overproduction of the follicle stimulating hormone (FSH) causes the endometrium to degenerate and slough off.

    c. When the corpus luteum degenerates, progesterone and estrogen levels decrease causing the endometrium to slough off.

    d. The luteinizing hormone directly influences the level of the follicle-stimulating hormone that, in turn, affects the level of estrogen in the woman's body.

9. Which of the statements below best describes the changes that occur at menopause?

    a. Due to changes in the primary follicles, the increases in the estrogen and progesterone do not occur.

    b. The primary follicles secrete more progesterone than estrogen.

    c. The endometrium degenerates and sloughs off producing hot flashes and anxiety.

    d. The ovaries become degenerated because of lack of estrogen and the follicle stimulating hormone.

10. An ectopic pregnancy occurs when a fertilized ovum:

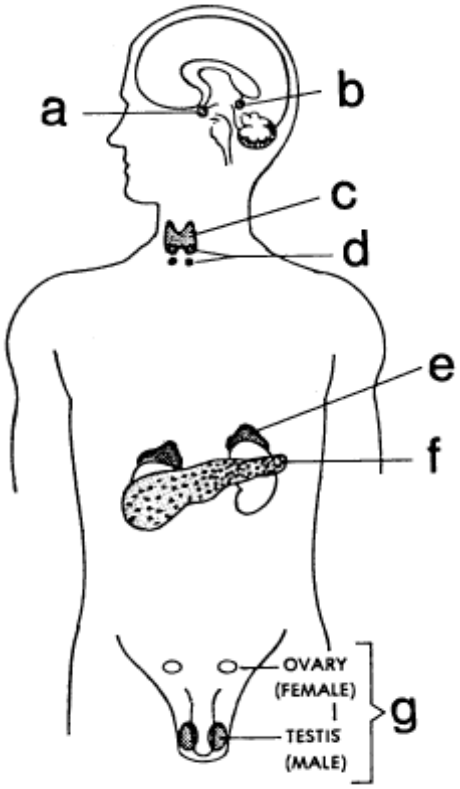
    a. Implants in the uterus.

    b. Implants in the placenta.

    c. Implants in an amniotic sac.

    d. Implants in a location other than the uterus.

SPECIAL INSTRUCTIONS FOR EXERCISES 11 THROUGH 13. For each question in Column A, select the appropriate answer in Column B based upon the following figure.



Column A	Column B
11. The arrow labeled “d” is pointing to:	a. Pituitary body.
12. The arrow labeled “f” is pointing to:	b. Parathyroid glands.
13. The arrow labeled “a” is pointing to:	c. Pineal gland.
	d. Adrenal (suprarenal) gland.
	e. Thyroid gland.
	f. Pancreatic islets.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 6

1. c (para 6-2d)
2. a (para 6-3c)
3. b (para 6-9)
4. b para 6-10b(2))
5. d (para 6-10b)
6. a (para 6-12a)
7. c (para 6-10b)
8. c (para 6-13)
9. a (para 6-15)
10. d (para 6-17)
11. b (Figure 6-1)
12. d (Figure 6-1)
13. a (Figure 6-1)

End of Lesson 6

LESSON ASSIGNMENT

LESSON 7 Thyroid, Antithyroid, and Parathyroid Preparations.

LESSON ASSIGNMENT Paragraphs 7-1 through 7-12.

LESSON OBJECTIVES After completing this lesson, you should be able to:

7-1. From a list of functions, select the function performed by the thyroid hormones.

7-2. Given the name of a condition caused by either hyposecretion or hypersecretion of thyroxin and a group of statements, select the statement that best describes that condition.

7-3. Given a group of statements, select the statement(s) that best describe precautions for persons who take thyroid preparations.

7-4. Given the trade and/or generic name of a thyroid preparation and a group of uses and side effects, select the use(s) or side effect(s) associated with the given agent.

7-5. Given a group of indications, select the indication(s) of antithyroid preparations.

7-6. Given the trade and/or generic name of an antithyroid preparation and a group of uses, side effects, or cautions and warnings, select the use(s), side effect(s), and caution(s) and warning(s) associated with the given agent.

7-7. From a group of statements, select the statement that best describes the indication for parathyroid preparations.

7-8. From a group of statements, select the statement that best describes hypoparathyroidism.

7-9. Given the trade or generic name of a thyroid, antithyroid, or parathyroid preparation and a group of trade and generic names, select the trade or generic name that corresponds to the given name.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 7

THYROID, ANTITHYROID, AND PARATHYROID PREPARATIONS

Section I. OVERVIEW

7-1. INTRODUCTION

The thyroid gland is a very important endocrine gland. This gland is located in the neck just below the larynx. This gland secretes the hormone thyroxin. Proper functioning of the thyroid gland is essential to normal functioning of the body. Either increased or decreased thyroid activity can present real problems to the patient. This lesson will focus attention on the thyroid gland and present some of the drugs available to treat both hypoactivity and hyperactivity of this important endocrine gland.

7-2. THE NATURAL THYROID HORMONES

Two hormones are responsible for the major functions of the thyroid. These hormones are thyroxine (T_4) and triiodothyronine (T_3). The notation T_4 reflects that the thyroxine nucleus has four iodine atoms attached to it. The notation T_3 means that three iodine atoms are attached to the thyroxine nucleus. Approximately, 10 times as much T_4 is secreted from the thyroid than T_3. As the T_4 circulates, some of it has iodine removed from the molecule. Hence, in terms of availability to body tissues, only about three times as much T_4 is available than T_3. Basically, because of differences in serum concentration and activity, the effects produced by these two hormones are identical for practical purposes. In order for these hormones to be synthesized in the body, sources of iodine must be present. When sufficient iodine is lacking in the diet, endemic goiters (enlarged thyroid) result. Such enlargement is due to hypersecretion of thyroid stimulating hormone (TSH) in an attempt by the body to obtain the required level of thyroid hormone secretion.

7-3. FUNCTION OF THE THYROID HORMONES

The hormones produced by the thyroid gland exert effects on most of the tissues of the body. Basically, the thyroid hormones maintain normal metabolic rate, allow the body to more rapidly use carbohydrates for energy, and promote the growth of tissues in the body.

7-4. HYPOTHYROIDISM

Hypothyroidism occurs when there is not enough thyroxin being secreted into the bloodstream. Depending on the age of the individual affected, various problems can result because of hypothyroidism.

a. **Cretinism.** Cretinism is the hyposecretlon of thyroxin in the newborn. This lack of thyroxin causes retardation of skeletal and nervous system growth. Untreated, this hyposecretion of thyroxin in a newborn can result in a mentally retarded dwarf. Early diagnosis and treatment of hypothyroidism is critical. Once detected, the newborn or infant can be given thyroxin so that development can be normal.

b. **Myxedema.** Myxedema is the hyposecretion of thyroxin in an adult (person after puberty). Myxedema is characterized by edema, fatigue, lethargy, sensitivity to cold, and other degenerative changes. In general, individuals suffering from myxedema feel tired and want to sleep a great deal (perhaps from 14 to 16 hours per day).

7-5. HYPERTHYROIDISM

Because the Irish physician, Robert Graves, first described hyper-thyroidism around 1835, this condition is usually referred to as Graves disease. Hyperthyroidism is increased secretion of thyroxine. Graves disease is characterized by anxious behavior, rapid pulse rate, increased appetite, weight loss, elevated metabolic rate, tremor of the hands, and exophthalmos (a condition in which the eyeballs slightly protrude from the sockets giving the patient a startled appearance). Graves's disease can be treated by the administration of Iodine 131 (I^{131}) or by surgery. Surgery is the first choice of treatment in patients whose age is between 25 and 40 and the second choice of treatment in patients 0 to 25 years.

Section II. THYROID PREPARATIONS

7-6. PRECAUTIONS FOR PATIENTS WHO ARE TAKING THYROID PREPARATIONS

From the preceding discussion, it is obvious that thyroid preparations affect the entire body. Therefore, persons who take these medications should be told of the following precautions.

a. **Regular Checkups.** An individual taking a thyroid preparation should schedule regular visits with the prescribing physician. These regular visits give the physician the opportunity to monitor the patient’s progress. Changes in the dosage of the medication may be required, the dosage of each of the agents below must be tailored to meet the individual needs of the patient. These regular checkups also give the patient an opportunity to tell the physician of any side effects the patient might be experiencing (e.g., changes in appetite, changes in menstrual periods, etc.).

b. **Exercise or Physical Work.** If the patient has certain types of heart disease, thyroid medication may cause shortness of breath or chest pain when the patient exerts himself when exercising or performing physical work. Hence, they should be cautioned against overdoing exercise or physical work. Specified questions the patient has concerning this precaution should be directed to the physician.

c. **Emergency Medical Treatment, Surgery, or Dental Surgery.** If the patient requires any emergency medical treatment, surgery, or dental surgery, the physician or dentist in charge should be told that the patient is taking thyroid medication.

d. **Over-The-Counter Medications.** Patients who take thyroid medications should be told not to take any other drug(s) unless the prescribing physician knows about the drug(s). The category of drugs includes over-the-counter medications. This is especially true of over-the-counter cold, cough, and appetite suppressant medications.

7-7. THYROID PREPARATIONS

You will see a variety of thyroid preparations in the pharmacy. Some of the medications you may dispense are discussed below.

a. **Thyroid, USP.** Thyroid, USP, is prepared from the thyroid glands of domesticated animals. Once the thyroid gland is obtained from the slaughtered animal, the gland is cleaned, dried, and powdered. Thyroid, USP, contains both the T_3 and T_4 hormone. This preparation is used in the treatment of hypo-thyroidism. The dosage of this product must be tailored to meet the needs of the individual patient. Side effects associated with this agent include changes in appetite, chest pain, diarrhea, and hand tremors.

b. **Levothyroxine (Synthroid®).** Levothyroxine is a synthetic source of the T_4 hormone. Once taken, approximately 30 percent of the levothyroxine is converted to the T_3 hormone. Levothyroxine is used in the treatment of hypothyroidism. Like Thyroid, USP, the dosage of levothyroxine must be individualized to meet the patient's needs. The usual dosage prescribed is from 0.1 milligram to 0.2 milligram taken daily in a single dose. Side effects associated with this agent include changes in appetite, chest pain, diarrhea, and hand tremors.

c. **Sodium Liothyronine (Cytomel®).** Liothyronine is a synthetic source of the T_3 hormone. This product is used in the treatment of hypothyroidism and male sterility due to hypothyroidism. As with the other thyroid preparations, the dosage of this product must be tailored to meet the needs of the individual patient. The dose usually prescribed is 25 to 50 micrograms daily in a single dose. Changes in appetite, chest pain, diarrhea, and hand tremors are side effects usually associated with this agent.

d. **Liotrix (Euthroid®).** Liotrix is a synthetic source of both T_3 and T_4 hormones. Liotrix is used in the treatment of hypothyroidism. The dosage of this product must be tailored to meet the needs of the individual patient. Side effects associated with this product include changes in appetite, chest pain, diarrhea, and hand tremors.

e. **Thyroglobulin (Proloid®).** Thyroglobulin is obtained from a purified extract of hog thyroid glands. This product provides both T_3 and T_4 hormones. Thyroglobulin is used in the treatment of hypothyroidism. The dosage of this preparation must be tailored to meet the needs of the individual patient. Adverse reactions associated with the use of this product include nervousness, sweating, and tachycardia.

7-8. MISCELLANEOUS PREPARATION

Strong Iodine Solution, USP (Lugol's solution). This preparation is used to provide the patient with a source of iodine. As noted in paragraph 7-2, a sufficient amount of iodine must be available to synthesize thyroid hormones. If iodine in the required amounts is lacking in the diet, the thyroid gland can become enlarged. The usual dosage of this product is 0.1 milliliters to 0.3 milliliters three times a day. The patient can take this medication in orange juice to mask the iodine taste.

Section III. ANTITHYROID PREPARATIONS

7-9. INTRODUCTION AND INDICATIONS

An anti-thyroid preparation inhibits the synthesis of thyroid hormones by interfering with the binding of iodine into an organic form. The administration of such a product is indicated in the treatment of hyperthyroidism and is sometimes given to a patient before thyroid surgery.

7-10. ANTITHYROID PREPARATIONS

a. **Methimazole (Tapazole®).** Methimazole is an antithyroid preparation used in the treatment of hyperthyroidism. It is also sometimes given to patients who are to undergo thyroid surgery or radiotherapy. Side effects associated with this agent include unexplained sore throat, fever, or chills; loss of hearing; swollen lymph nodes; increase in urination; and unusual bleeding or bruising. The dosage of this drug must be tailored to meet the individual needs of the patient. This medication should not be taken by pregnant women. Further, a woman should not take this preparation if she is breast-feeding an infant. You should also inform the patient that the medication should be taken each day in regularly spaced doses in order to achieve its desired effect. The medication should be taken at about the same time and the same way. This is, if the patient takes the medication with food, it should always be taken with food; if the medication is taken on an empty stomach, it should always be taken on an empty stomach. Two last precautions that should be communicated to the patient taking this drug are: (a) inform the physician or dentist before you have any type of surgery and (b) inform the physician immediately if you get an injury, infection, or illness of any type.

b. **Propylthiouracil (Propacil®).** Propylthiouracil is an antithyroid preparation used in the treatment of hyperthyroidism and it is sometimes given to patients who are to undergo thyroid surgery or radiotherapy. Side effects and precautions associated with the use of this agent are the same as those discussed under methimazole (Tapazole®) (para 7-10a). You should know that some prescribers will occasionally write PTU meaning propylthiouracil. Some patients go into remission after therapy with Tapazole® or Propacil®.

Section IV. PARATHYROID PREPARATIONS

7-11. INTRODUCTION AND INDICATION FOR USE

The parathyroid glands secrete the hormone parathormone (Lesson 6, para 6-9). This hormone regulates the amount of calcium in the intracellular fluid. The parathyroid preparations are used in the treatment of hypoparathyroidism. Hypoparathyroidism can occur spontaneously or with injury to the parathyroid glands. Hypoparathyroidism is characterized by a decrease in the concentration of calcium in the serum and an increase in the concentration of phosphorus in the serum. Overdosage of parathyroid preparations can be potentially dangerous because serum levels of calcium can reach very high levels. If the serum concentration of calcium reaches too high a level, calcification of kidneys and blood vessels can occur.

7-12. PARATHYROID PREPARATIONS

a. **Parathyroid Injection, USP.** This product is obtained from the parathyroid glands of freshly slaughtered domesticated animals like cattle. The preparation is used in the treatment of hypoparathyroidism.

b. **Dihydrotachysterol (Hytakerol®).** This product increases the level of calcium in the serum by mobilizing calcium from bones and by increasing calcium absorption from the intestines. Hence, it is used in the treatment of hypocalcemia.

Continue with Exercises

EXERCISES, LESSON 7

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Select the function below that is performed by the thyroid hormones.

   a. Prevents the growth of tissues in the body.

   b. Maintains the normal metabolic rate of the body.

   c. Prevents the body from using carbohydrates for energy.

   d. Produces endemic goiters.

2. Cretinism is described as:

   a. A condition in which there is a hyposecretion of thyroxin in the newborn that can be treated with the administration of propythiouracil.

   b. A hyposecretion of thyroxin in the newborn that can result in retardation of the skeletal and nervous systems if left untreated.

   c. The hypersecretion of thyroxin in an adult that can result in mental retardation.

   d. A hyposecretion of thyroxin in an adult that is characterized by edema, fatigue, lethargy, and sensitivity to cold.

3. Which of the following statements best describes a precaution for persons who take thyroid preparations?

   a. Patients taking thyroid preparations should tell the dentist or physician they are taking these medications.

   b. Patients taking thyroid preparations should not exercise.

   c. Patients taking thyroid preparations should avoid any type of vitamin preparation.

   d. Patients taking thyroid preparations should avoid eating iodized salt.

4. One of the side effects associated with levothyroxine is:

   a. Hypotension.

   b. Hypothermia.

   c. Constipation.

   d. Changes in appetite.

5. Sodium liothyronine is a synthetic source of the _____ hormone.

   a. T_1.

   b. T_2.

   c. T_3.

   d. T_4.

6. An antithyroid preparation is sometimes indicated when the patient is:

   a. Diagnosed as having a diet lacking in iodine.

   b. Having difficulty with an infection.

   c. About to undergo thyroid surgery.

   d. Being treated for swollen lymph nodes.

7. All patients taking Tapazole® should be told:

   a. “Do not take any other medications while you are taking this drug.”

   b. “Do not take this medication if you are breast feeding an infant.”

   c. “Your lymph nodes may become sore and swollen after you take this medication for a while.”

   d. “Take the medication at about the same time each day and take it the same way each time (that is, with food).”

8. While working in the outpatient pharmacy, you receive a prescription written for PTU. What is the name of this medication and what is it used?

   a. Propythlouracil, used in the treatment of hyperthyroidism.

   b. Parathroid, used in the treatment of hyperthyroidism.

   c. Para-amino-benzoic acid, used in the treatment of sunburn.

   d. Phenolated triethane urea, used in the treatment of kidney disease.

9. Hypoparathyroidism is described as:

   a. A condition characterized by a decrease in the concentration of calcium in the serum and an increase in the concentration of phosphorus in the serum.

   b. A condition that can result in the calcification of the blood vessels in the abdominal area.

   c. A condition caused by excessive intake of calcium and potassium.

   d. A condition caused by undersecretion of thyroxin.

SPECIAL INSTRUCTIONS FOR EXERCISES 10 THROUGH 13. In exercises 10 through 13, match the trade name in Column B with its corresponding generic name in Column A.

Column A	Column B
10. ___ Levothyroxine	a. Synthroid®
11. ___ Propythiouracil	b. Propacil®
11. ___ Dihydrotachysterol	c. Hytaberol®
13. ___ Thyroglobulin	d. Proloid®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 7

1. b (para 7-3)
2. b (para 7-4a)
3. a (para 7-6c)
4. d (para 7-11)
5. c (para 7-7c)
6. c (para 7-9)
7. d (para 7-10a)
8. a (para 7-10b)
9. a (para 7-11)
10. a (para 7-7b)
11. b (para 7-10b)
12. c (para 7-12b)
13. d (para 7-7e)

End of Lesson 7

LESSON ASSIGNMENT

LESSON 8	Reproductive Hormones and Oral Contraceptives.
LESSON ASSIGNMENT	Paragraphs 8-1 through 8-22.
LESSON OBJECTIVES	After completing this lesson, you will be able to:

8-1. Given the name of one of the three main categories of reproductive hormones and a group of statements, select the statement that best describes that hormone.

8-2. Given the name of one of the three main categories of reproductive hormones and a group of statements, select the statement that describes the use of that hormone or the side effects associated with that hormone.

8-3. Given the trade or generic name of a specific estrogen, progestin, or androgen agent and a list of uses, patient warning statements, and side effects, select the use(s), patient warning statement(s), and side effect(s) associated with the given agent.

8-4. Given the trade or generic name of a specific estrogen, progestin, androgen agent, or oral contraceptive and a group of trade and/or generic names, select the trade or generic name that corresponds to the given name.

8-5. Given the name of one of the methods of contraception and a group of statements, select the statement that best describes that method of contraception.

8-6. Given a group of statements, select the statement that describes a mechanism of action of oral contraceptives.

8-7. Given a group of statements, select the statement that best describes one of the three types of oral contraceptives.

8-8. Given a group of effects, select the side effect associated with the use of oral contraceptives.

8-9. Given a group of statements, select the statement that describes what a patient who is beginning to take oral contraceptives should be told.

8-10. Given the name of an oral contraceptive, classify that agent into one of three given categories of oral contraceptives (for example, estrogen product alone).

8-11. Given the trade or generic name of an ovulation-inducing agent and a group of statements, select the statement that describes the property, use, dispensing information, or side effects associated with that agent.

8-12. Given the trade or generic name of an ovulation-inducing agent and a group of trade and/or generic names of drugs, select the trade or generic name corresponding to the given name.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 8

REPRODUCTIVE HORMONES AND ORAL CONTRACEPTIVES

Section I. INTRODUCTION

8-1. GENERAL COMMENTS

For many years people have attempted to better understand the reproductive process. The reasons why people have desired to learn more about reproduction are many. Some wish to identify and alleviate problems that prevent them from having children. Others want to identify and use ways to prevent pregnancy. You will dispense drugs that affect the reproductive process. Hence, you should be familiar with these agents and how they affect the reproductive system as well as the entire body.

8-2. REPRODUCTIVE HORMONES

There are three main categories of reproductive hormones, estrogens, progestins, and androgens.

a. **Estrogens.** In females, estrogens are secreted by the developing ovarian follicle and by the corpus luteum (see Lesson 6, para 6-11b). During pregnancy, the placenta secretes estrogens. Estrogens are responsible for the development of the uterus, vagina, fallopian tubes, and breasts. Estrogen also produces such physiological effects as accelerating growth at puberty (causes epiphyses of long bones to close), increasing clotting factors in circulation, and decreasing bone reabsorption. Estrogen produces female secondary sex characteristics (like distribution of fat, development of pubic hair, high-pitch voice, and increased skin pigmentation). In males, there is limited estrogen secretion by the adrenal glands.

b. **Progesterone.** Progesterone is the hormone that prepares the female's body for pregnancy and helps maintain pregnancy. That is, this hormone decreases the motility of the uterus, allowing the fertilized egg to implant and remain implanted in the uterus. Progesterone also develops the milk-secreting cells of the breasts. Decreased levels of progesterone cause irregularity of the menstrual cycle.

c. **Androgens.** In males, the androgens are produced in the testes. Testosterone is the principal and most powerful androgen. Physiologically, the androgens affect the following:

(1) Development of the testes, vas deferens, the prostate, seminal vessicles, penis, and scrotum.

(2) Growth at puberty and the length of long bones (closes epiphyses of long bones).

(3) Anabolism increases the synthesis and decreases the breakdown of protein. Androgens also act to produce secondary sex characteristics associated with the male (like development of pubic hair and facial hair, development of a deeper pitched voice, and development of increased sebaceous secretions). In females, there is limited androgen production by the adrenal glands.

Section II. USES OF REPRODUCTIVE HORMONES

8-3. INTRODUCTION

In the previous section, the reproductive hormones were discussed in terms of their site of production and the effects produced on the body. As you have probably realized by now, these substances affect the body in many ways. Therapeutically, physicians take advantage of the different ways these substances affect the body in order to use them to treat certain disease conditions. This section will focus on the uses associated with the reproductive hormones discussed in Section I.

8-4. USES OF ESTROGEN

Estrogen has a variety of uses in medical practice. Following are some of those uses:

a. **Hormonal Replacement.** In cases where there is insufficient estrogen present, the woman can suffer various conditions (like dryness of the vagina). The lack of sufficient estrogen in the woman's body could be attributed to surgery (removal of the ovaries), to menopause, or to other conditions. In such cases, the physician might elect to prescribe estrogen therapy to provide the needed estrogen.

b. **Palliative Treatment of Breast Cancer and Prostatic Cancer.** Palliative refers to lessening the severity of symptoms or pain, such treatment does not necessarily mean cure. Estrogen is sometimes administered to relieve "bone pain," a condition experienced by some men who have cancer of the prostate that has metastasized to bone causing severe pain. In females, some breast tumors are sensitive to estrogens if there is an "estrogen receptor" present. The presence of such an estrogen receptor can be determined by laboratory tests. If such a receptor is present, estrogen therapy can lead to a decrease in the size of the tumor. At the present time, it is not known if an estrogen receptor is present in cases involving cancer of the prostrate. It is recommended that other treatment (for example, chemotherapy) be used in conjunction with estrogen therapy.

c. **Oral Contraceptive.** Estrogen alone, or in conjunction with progesterone, can be used to prevent pregnancy.

d. **Treatment of Postpartum Breast Engorgement and Bleeding.** Within 24 to 48 hours after delivery, the mother's breasts will become swollen and tender. If the mother intends to breast feed the infant, the nursing staff will provide care to help alleviate the pain. After a while, the pain will subside. If the mother does not wish to breast feed the infant, estrogen can be administered. A large dose of estrogen will feed back to the pituitary gland through the hypothalamus. Prolactin release will be inhibited and the breast engorgement will not occur. You should know that the use of estrogen to treat postpartum breast engorgement is not recommended because of the risk of clot formation. Such administration of estrogen is soon after delivery. Estrogen can also be given to decrease uterine bleeding, since estrogen stimulates the repair of the uterus and vagina (increases the lining of these structures).

e. **Treatment of Acne.** At one time physicians frequently prescribed estrogens in the treatment of severe acne. The estrogens caused the sebaceous secretions to be more fluid. Hence, the pores did not tend to clog so easily. You should know that this treatment is not as popular as it once was. Today other products are sometimes given in conjunction with antibiotics (for example, tetracyclines) in the treatment of acne.

8-5. SIDE EFFECTS ASSOCIATED WITH ESTROGEN THERAPY

As you might expect, there are some side effects associated with the use of estrogens. Some of these side effects are listed and discussed below:

a. **Bleeding.** Women on estrogen therapy sometimes experience vaginal bleeding. Such bleeding can be prolonged. When bleeding occurs with estrogen therapy, the patient should contact the physician.

b. **Headaches.** Headaches associated with estrogen therapy may be sudden in onset and/or severe in nature.

c. **Edema and Breast Tenderness.** The breast may enlarge because of fluid buildup, which cause the breasts to be very tender.

d. **Nausea and Vomiting.**

e. **Thrombo Embolic Disease.** Administration of estrogen can cause an increase in the likelihood of clot formation.

f. **Increased Incidence of Cancer.** There appears to be a higher incidence (five to 15 times) of endometrial cancer in postmenopausal patients that use estrogens, especially, patients who have taken estrogens for a long period of time (five years or longer).

g. "**In Utero" Effects on the Fetus.** In the 1950s and 1960s, females who were habitual aborters were given an estrogen product called diethylstilbestrol (DES). This drug was given in order for the habitual aborters to have children. The children they gave birth to have been found to have been affected by this drug. Some female offspring have been found to have an increased incidence of vaginal cancer. Some male offspring have decreased semen volume, sperm density, and mobility and hypertrophic testes.

h. **Increased Dietary Requirements for Vitamin B6 and Folic Acid.** Estrogens interfere with the absorption of these substances from the gastrointestinal tract. Hence, the patient may have to increase intake of these substances in order to absorb body requirements.

8-6. USES OF PROGESTINS

Progestins are used as listed and discussed below:

a. **Oral Contraceptive.** Progestins are used either alone or in combination with estrogens as oral contraceptives.

b. **Cancer Treatment.** Some progestins (for example, megestrol acetate) can be used in the treatment of certain types of cancer. Specifically, these agents are used in the treatment of breast cancer and cancer of the endometrium. The mechanism by which these products produce this anticancer effect is unknown. In the treatment of these cancers, the progestins are used in conjunction with other agents.

c. **Progestinic Supplement.** Progestins are prescribed in instances in which insufficient amounts of progestins are produced by the body.

8-7. SIDE EFFECTS ASSOCIATED WITH PROGESTIN THERAPY

Progestins may be estrogenic or androgenic in terms of the effects they produce. The various actions of progestins seem to be responsible for the side effects observed with their use. Immediately below are some of the side effects associated with progestins.

a. Changes in vaginal bleeding patterns (breakthrough bleeding or complete lack of bleeding can occur with these agents).

b. Severe or sudden headaches may occur with these agents.

c. Sudden loss of coordination.

d. Changes in appetite.

e. Changes in weight (can be caused by edema).

8-8. PRECAUTIONS ASSOCIATED WITH THE USE OF PROGESTINS

Progestins should not be taken during the first four months of pregnancy because of the potential harm they can cause the fetus. Progestins, because of the effects they produce, may delay the spontaneous abortion of a defective fertilized egg.

8-9. USES OF ANDROGEN THERAPY

a. **Androgen Replacement Therapy.** In some instances, there is a lack or insufficient amount of androgen produced by the testes. For example, the testes may have been surgically removed or damaged in some way. In these cases, androgens may be given to the man.

NOTE: Testicular cancer is most common in the young male from age 18 to 30. This type of cancer can be fatal if not diagnosed and treated early. Therefore, any lump on the testes should be cause for an immediate medical check. The loss of the testes will cause sterility. However, loss of the testes will not affect the ability to have an erection, ejaculation, or orgasm.

b. **Treatment of Osteoporosis.** Androgens are administered in osteoporosis in order to cause a rebuilding of bone.

c. **Treatment of Endometriosis.** Endometriosis is the uncontrolled growth of uterine endometrium. Androgens are given to treat endometriosis.

d. **Reduction of Protein Loss.** Androgens can be especially useful in the debilitated or geriatric patient to reduce the amount of protein lost from muscle tissue. In the use of androgens for this purpose, additional protein should be added to the diet in order for the body to synthesize the required proteins.

8-10. SIDE EFFECTS ASSOCIATED WITH ANDROGEN THERAPY

Because of the actions of androgens, they produce characteristic side effects. Some of the most widely observed side effects are:

a. **Edema.** To a slight extent androgens increase sodium and water retention in the kidney.

b. **Masculinizing Effects.** The androgens are responsible for producing the secondary male characteristics. Some of these characteristics include deepening the voice and increased hair on the body.

Section III. SPECIFIC REPRODUCTIVE HORMONES

8-11. INTRODUCTION

In the previous sections, general concepts related to reproductive hormones were presented. You were told of the effects, uses, and side effects associated with these agents. In this section, specific reproductive hormones will be discussed.

8-12. SPECIFIC ESTROGEN AGENTS

a. Conjugated Estrogens (Premarin®). Premarin® is used in estrogen replacement therapy. Side effects associated with Premarin® are listed in paragraph 8-5. Provide the patient with a patient package insert (PPI) when dispensing this product. Premarin® is available in tablet, topical cream, vaginal cream, and injectable forms.

b. **Chlorotrianisene (Tace®).** This estrogen is used to prevent postpartum breast engorgement. The usual dosage of this product is 12 milligrams four times daily for seven days or 50 milligrams every six hours for six doses. Because of the short duration of therapy associated with this product, nausea and vomiting are often associated with its use. Tace® also produces side effects such as those listed in paragraph 5-8 in some patients. When you dispense this product you should inform the patient that the medication should be taken until it is gone. Furthermore, a PPI should be provided to the patient when this product is dispensed. Tace® is supplied in capsule form.

c. **Ethinyl Estradiol (Estinyl®).** This estrogen product is used for estrogen replacement therapy, in the palliative treatment of cancer, and as a contraceptive. For the side effects associated with this agent, read paragraph 8-5. Provide the patient with a patient package insert when this product is dispensed. Estinyl® is available in tablet form.

d. **Dienestrol.** This estrogen product is used in estrogen replacement therapy and in the treatment of atrophic vaginitis. (Atrophic vaginitis is a condition sometimes observed in postmenopausal women. Dryness and itchiness of the vagina characterize it.) This preparation is supplied in the form of a cream. The usual dose of this product is one applicator full applied vaginally. Since this product is absorbed locally, the side effects associated with this agent are the same as for the other estrogens. Provide the patient with a PPI when you dispense this product.

e. **Diethylstilbestrol (Stilphostrol®).** This estrogen is used in estrogen replacement therapy, in the palliative treatment of breast and prostate cancer, and as a contraceptive (given as a single high dose following rape). Diethylstilbestrol (DES) is not routinely used as an oral contraceptive. The dosage of the product varies with the use. For the side effects associated with this agent, you should read paragraph 8-5. When you dispense the product, you must provide the patient with a PPI. If the product is being dispensed as a contraceptive, you should tell the patient to take the medication until it is gone. Since this preparation may affect the clotting of the blood, the patient should be told to inform the doctor or dentist the drug is being taken before any surgery is attempted. Furthermore, a female of childbearing age that is taking this product should be told that the drug can cause birth defects if it is taken during pregnancy. Diethylstilbestrol is available in tablet and suppository form.

8-13. SPECIFIC PROGESTIN AGENTS

> **IMPORTANT NOTE**: You must give the patient the PPI when you dispense these products.

a. **Medroxyprogesterone (Provera®).** This product is used in the treatment of amenorrhea and dysmenorrhea and in progestin replacement therapy. Side effects associated with this agent are few when it is taken in cycles. This product is available in tablet and injectable forms.

b. **Hydroxyprogesterone (Delalutin®).** This product is used in the treatment of amenorrhea and in the palliative treatment of uterine cancer. For the side effects associated with this agent, read paragraph 8-7. Delalutin® is available in an injectable form.

c. **Dydrogesterone (Duphaston®).** Dydrogesterone is used in the treatment of amenorrhea and in the palliative treatment of uterine cancer. For a description of the side effects associated with this product, you should read paragraph 8-7. This product is available in an injectable dosage form.

d. **Megestrol (Megace®).** Megestrol is only used in the treatment of cancer of the breast and endometrium. For product side effects, see paragraph 8-7.

e. **Norethindrone (Micronor®).** Norethindrone is used in the treatment of amenorrhea and endometriosis and as an oral contraceptive. For the side effects associated with norethindrone, read paragraph 8-7.

f. **Norgestrel (Ovrette®).** Norgestrel is only indicated for use as an oral contraceptive. See paragraph 8-7 for a description of the side effects associated with this agent.

g. **Progesterone (Luteogan®).** Progesterone is used in the treatment of amenorrhea and functional uterine bleeding. For the side effects associated with this agent, you should read paragraph 8-7.

8-14. SPECIFIC ANDROGEN AGENTS

a. **Danazol (Danocrine®).** Danazol is used in the treatment of endometriosis. (Endometriosis is a condition in which there is uncontrolled growth of uterine endometrium.) Side effects associated with danazol include increased oiliness of the hair or skin, acne, decreased breast size, and unnatural hair growth. This product is available in capsule form.

b. **Fluoxymesterone (Halotestin®).** Fluoxymesterone is used as an androgen hormonal supplement. Side effects associated with this agent include closing of the epiphyseal closures, hypercalcemia, and edema. This product should not be given to boys who are in puberty because of its effect on the epiphyseal closures. Fluoxymesterone is available in tablet form.

c. **Methyltestosterone.** Methyltestosterone is used as an androgen replacement. Side effects associated with this product include hypercalcemia, edema, and development of male secondary sexual characteristics (if used in women). Methyltestosterone is supplied in oral, buccal, or sublingual tablets.

Section IV. CONTRACEPTION

8-15. INTRODUCTION

For years people have been searching for a truly safe and effective contraceptive. Both physical and chemical means have been tried to prevent the process of fertilization. Some chemical means have been found which prevent contraception; however, this means also highly undesirable side effects. The topic of contraception will be presented and discussed in this section. Specifically, the methods of contraception will be examined in relation to their advantages and disadvantages.

8-16. METHODS OF CONTRACEPTION

Immediately below, some methods of contraception are discussed. You are probably familiar with most of these methods.

a. **Abstinence.** Abstinence, in this sense, means that one refrains from engaging in sexual intercourse. Theoretically, this means that abstinence is 100 percent effective in preventing pregnancy. However, intercourse does not have to occur in order for fertilization of the egg to occur. If sperm are deposited in one way or another in or around the vagina, it is possible that sperm could move themselves up the vaginal canal and eventually fertilize the egg.

b. **Coitus Interruptus/Withdrawal.** In this method, the penis is withdrawn from the vagina before ejaculation of sperm occurs. The advantages of this method are two: (1) no chemicals are involved and (2) no devices are used. The disadvantage of this method is that the method sounds better than it actually is. Realistically, some movement of sperm from the penis takes place before ejaculation. Actually, about one-fourth of the couples who practice this method end up with the female pregnant.

c. **Rhythm Method.** In an earlier lesson (see para 6-13), the topic of the female's monthly period (cycle) was discussed. Knowing what is involved in this cycle allows one to predict quite accurately (for many women) when intercourse could result in pregnancy. Many women have 28-day cycles, but other women deviate from this 28-day pattern. Various methods (for example, use of the basal body thermometer (BBT)) have been used to increase the accuracy of the method. As you might think, this method can be used to prevent pregnancy as well as to plan pregnancy. An advantage of this method is that no chemicals are used. A disadvantage is that miscalculation can result in pregnancy. Approximately one-fourth of the couples who used this method found that the female became pregnant.

d. **Spermicide Method.** The spermicide method involves the use of foams, creams, jellies, and suppositories to kill sperm after ejaculation has occurred. Individuals using this method should carefully follow the directions supplied with the spermicidal product. In terms of effectiveness, about 22 percent of the couples using this method find that the female becomes pregnant. One advantage of this product is that no hormones are involved. There are two primary disadvantages associated with this method. First, some products can cause irritation. Second, most products require that they be applied inside the vagina approximately 15 minutes before intercourse is to occur. This takes planning and is somewhat inconvenient.

e. **Prophylactic (Condom) Method.** In this method, a condom is used to cover the penis in order that ejaculated sperm cannot enter the vagina. Hence, this method is a mechanical block against pregnancy. This method also serves to reduce the chances of contracting of venereal disease from the sexual partner. In terms of effectiveness of pregnancy prevention, approximately 10 of 100 couples who use this method find the female becomes pregnant. The advantage of this method is that no chemicals are used and the method is convenient. The disadvantage of this method is that it affects the spontaneity of the sexual act. In addition, the condom may be defective. If defective, sperm can escape from the condom and enter the vagina. You should remember to use only a surgical lubricant (like K-Y® Jelly) on the condom since petroleum can dissolve the vulcanized rubber that is used to make most condoms.

f. **Diaphragm.** This method involves the use of a mechanical block in conjunction with spermicide. Specifically, a mechanical device is inserted in the vagina. A spermicidal product is applied around the diaphragm. Theoretically, this mechanical/chemical block should prevent pregnancy. Actually, approximately five of 100 couples who use this method find the female pregnant. The advantage of this method is that no hormone is used. The disadvantages of this method are that the diaphragm must be fitted (requires a prescription) and there is some difficulty in inserting the diaphragm.

g. **Intrauterine Device (IUD).** This method involves the use of a mechanical device (like a coil or loop) placed within the uterus. The IUD is believed to prevent the implantation of the fertilized ovum. There are various types of these intrauterine devices available. Some intrauterine devices contain chemicals (like copper or progesterone). Approximately five of 100 couples who use this method find the female becomes pregnant. The advantage of this method is that no chemicals are used (except in the two types that contain chemicals). Disadvantages associated with intrauterine devices are that they are not always inserted properly by the females and they can move and irritate tissue. Further, the intrauterine device can present problems to the female and fetus if the female becomes pregnant while the IUD is in place, if the IUD is removed there is a high likelihood of a miscarriage.

h. **Surgical Techniques.** A vasectomy is a surgical procedure that blocks the flow of sperm from the epididymis. This procedure is very effective. A tubal ligation is a surgical procedure that blocks the movement of ovum in the female. Both methods are extremely effective in making the individual sterile. The advantage of these surgical methods is that they are both effective and permanent. A disadvantage is that they are permanent, although some success has been achieved in surgically reversing the procedure.

i. **Oral Contraceptives.**

(1) Mechanism of action. Oral contraceptives act by three methods:

(a) Increase an estrogen level that inhibits ovulation by feedback action on the hypothalamus and subsequent suppression of the follicle-stimulating hormone (FSH) and lutinizing hormone (LH).

(b) Increases progesterone levels prior to ovulation, which inhibit the implantation of the ovum within the uterus.

(c) Affect the quality of the mucous in the vagina (the mucous becomes thick, scanty, and cellular) in order to hamper the movement of sperm.

(2) Types of oral contraceptives.

(a) Estrogen and progestin combination products. These preparations are supplied in a package containing 21 or 28 tablets. In that package, 21 of the tablets contain a combination of estrogen and progestin and seven tablets contain inert ingredients or iron (25 milligrams of elemental iron per tablet).

(b) Low dose progesterone products. These products contain progesterone. A tablet is to be taken each day of the cycle.

(c) High dose estrogen (DES). This tablet is taken within 72 hours of intercourse. High dose estrogen is not a routinely used oral contraceptive. It is only used in cases of rape and incest.

(3) Side effects. Some significant side effects are associated with the use of oral contraceptive agents. Some of these are:

(a) Breakthrough bleeding. This side effect is seen in patients taking low-dose estrogen.

(b) Thromboembolic disease. Symptoms associated with this particular side effect include severe headache, blurring or loss of vision, flashing lights, leg pains, chest pains, and shortness of breath.

(c) Candida vaginitis. This is a yeast infection of the vagina. This side effect is sometimes seen in patients taking high progestin products.

(d) Edema and breast enlargement. This side effect is seen most often in patients taking high estrogen and/or progestin products.

(e) Nausea and vomiting. This side effect is most often observed in patients taking high estrogen products.

(f) Skin reactions. Increased pigmentation can be aggravated by sunlight. This side effect is more common in individuals who have darker skin. This type of side effect is observed most often in patients who are taking high estrogen products.

(g) Libido changes. Oral contraceptives sometimes affect the individual's sex drive.

(h) Rebound fertility. Rebound fertility involves the increased likelihood of pregnancy. The cause of this side effect is unknown.

8-17. GENERAL DIRECTIONS FOR TAKING ORAL CONTRACEPTIVES

The patient should begin taking the medication on the fifth day after menstrual flow begins. Then, one tablet should be taken daily until all the tablets are gone. The patient should stop for seven days (if taking the 21-day packet) and then repeat the 21-day cycle. For patients who have 28-day packets, they should not stop taking tablets between cycles. If the menstrual period does not occur, check with the physician to rule out pregnancy.

NOTE: It is advisable to use alternative methods of contraception when using "the pill" for the first cycle. That is, use a combination of condom/spermicidal foam. Always provide the patient with a PPI each time you dispense an oral contraceptive.

8-18. GOAL OF CONTRACEPTIVE THERAPY

a. The goal of contraceptive therapy is to use as low a dose as possible. If a tablet is missed, it should be taken when remembered. If the patient vomits within two hours after taking the tablet, a second tablet should be taken. When in doubt, the patient should use a second method of contraception.

b. Not all estrogens and progestins are equipotent. For example, norethindrone acetate is twice as potent as norethindrone. Therefore, the lowest weight combination is not necessarily the least potent.

8-19. EXAMPLES OF ORAL CONTRACEPTIVES BY TYPE

a. **Progestin Product Alone.**

(1) Norethindrone (NOR-QD®, MICRONOR®).

(2) Norgestrol (Ovrette®).

b. **Combination Products (Estrogen and Progesterone).**

(1) Norethindrone/mestranol (Ortho-Novum®).

(2) Nogestrel/ethinyl estradiol (Ovral®).

(3) Ethynodiol acetate/ethinyl estradiol or mestranol (Demulen®).

(4) Norethindrone/ethinyl estradiol (Brevicon®).

8-20. PRECAUTIONARY STATEMENT

Oral contraceptives (just like any other type of legend drug) should not be given to friends. A physician must individually select the agent and tailor the dosage based on the history and needs of the patient. A physical examination should be performed every six months to one year. One part of this examination should be the PAP smear. Remember that oral contraceptives are potentially dangerous. A person should never be unless they have been prescribed for the person.

Section V. OVULATION INDUCING AGENT

8-21. INTRODUCTION

In some instances the physician may desire to stimulate ovulation in order that the patient can become pregnant. This section will focus on an agent that will stimulate ovulation.

8-22. CLOMIPHENE CITRATE (CLOMID®), AN OVULATION INDUCING AGENT

a. **Properties.** Clomiphene is a nonsteroidal compound. This agent has properties that are estrogenic and antiestrogenic properties. It has been used to stimulate ovulation in order that the female can become pregnant (if the male partner has adequate sperm production).

b. **Dispensing Information.** Frequently, a two or three month supply of Clomid® is dispensed to the patient since a month of therapy is usually not successful.

c. **Side Effects.** Side effects associated with this agent include enlarged ovaries (this can be painful), hot flashes, and multiple pregnancies.

Continue with Exercises

EXERCISES, LESSON 8

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Progesterone is best described as:

   a. The hormone responsible for female secondary sexual characteristics.

   b. The hormone that prepares the female’s body for pregnancy and helps maintain pregnancy.

   c. The hormone that affects the growth of bone during puberty (closes epiphyses of long bones).

   d. The hormone responsible for the development of the uterus, vagina, and fallopian tubes.

2. Estrogen is used in the palliative treatment of breast cancer and prostatic cancer. This means that:

   a. Estrogen lessens the severity of symptoms or pain, but it does not cure the patient.

   b. Estrogen causes a complete remission of the cancer in the patient.

   c. Estrogen is used in combination with other agents in order to slow the spread of the cancer throughout the body.

   d. Estrogen can be used to treat cancers that have not spread throughout the body.

3. When you dispense diethylstilbestrol to a patient you must:

    a. Inform the patient that the drug is used in estrogen replacement therapy and in the palliative treatment of breast and prostate cancer.

    b. Tell the patient to take the medication until it is gone.

    c. Tell the patient that the drug has been known to cause atrophic vaginitis in women who are of childbearing age.

    d. Provide the patient with a patient package insert (PPI).

4. The diaphragm method of birth control involves the use of:

    a. A mechanical device placed within the uterus.

    b. A spermicide in conjunction with a mechanical block inserted in the vagina.

    c. A condom used to cover the penis In order that ejaculated sperm cannot enter the vagina.

    d. A dome-shaped rubber device that is placed over the opening of the vagina.

5. Which of the following statements best describes a mechanism of action associated with some oral contraceptive agents?

    a. Some oral contraceptives make vaginal secretions (mucous) watery and noncellular in order to hamper the movement of the sperm.

    b. Some oral contraceptives increase progesterone levels that inhibit ovulation by feedback action on the hypothalamus and subsequent suppression of the follicle-stimulating hormone and lutinizing hormone.

    c. Some oral contraceptives increase progesterone levels prior to ovulation, which inhibit the implantation of the ovum within the uterus.

    d. Some oral contraceptives block the action of the follicle-stimulating hormone by depressing the action of the cilia of the fallopian tube.

6. Which of the following describes the category of oral contraceptives commonly referred to as "combination products''?

   a. Progesterone and estrogen products are together in the same product.

   b. Progesterone and androgen drugs are combined in order to affect ovulation and ovum implantation in the uterus.

   c. Estrogen and clomiphene citrate is combined in order to prevent pregnancy.

   d. Estrogen and androgens are administered in separate dosage forms in order to simulate pregnancy and interfere with progesterone levels in the blood.

7. Select the side effect associated with the use of oral contraceptives.

   a. Breakthrough bleeding.

   b. Hypertension.

   c. Hypotension.

   d. Hypoglycemia.

8. Which of the following statements should be told to the patient who has just started to take an oral contraceptive?

   a. The patient can miss as many as two consecutive days of taking the oral contraceptive, if the monthly menstrual cycle is regular.

   b. Use alternative methods of contraception when using “the pill” for the first cycle.

   c. If the patient vomits within two hours after taking the tablet, the patient should wait until the next day to take the next tablet.

   d. If the patient is on a trip and forgets to bring the oral contraceptive with her, she can take as many as three oral contraceptive tablets from a friend.

9. Diethylstilbesterol (DES) is used:

   a. Routinely as an oral contraceptive by many women.

   b. To prevent pregnancy in cases of rape and incest.

   c. To stimulate the production of milk.

10. Select the side effect associated with the use of clomiphene citrate.

   a. Increased likelihood of becoming pregnant.

   b. Changes in sex drive.

   c. Candida vaginitis.

   d. Multiple pregnancies.

SPECIAL INSTRUCTIONS FOR EXERCISES 11 THROUGH 14. In exercises 11 through 14, match the trade name listed in Column B with its corresponding generic name listed in Column A.

Column A	Column B
11. ___ Clomiphene citrate	a. Clomid®
12. ___ Norgestrel	b. Halotestin®
13. ___ Norethindrone/mestranol	c. Ortho-Novum®
14. ___ Fluoxymesterone	d. Ovrette®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 8

1. b (para 8-2b)
2. a (para 8-4b)
3. d (para 8-12e)
4. b (para 8-16f)
5. c (para 8-16i(1)(b))
6. a (para 8-19)
7. a (para 8-16i(3)(a))
8. b (para 8-17, Note 1)
9. b (para 8-12e)
10. d (para 8-22c)
11. a (para 8-22)
12. d (para 8-13f)
13. c (para 8-19b(1))
14. b (para 8-14b)

End of Lesson 8

LESSON ASSIGNMENT

LESSON 9 Adrenocortical Hormones.

LESSON ASSIGNMENT Paragraphs 9-1 through 9-14.

LESSON OBJECTIVES After completing this lesson, you should be able to:

9-1. From a list of names of hormones, select the three general types of hormones produced by the cortex of the adrenal gland.

9-2. From a list of names of hormones, select the primary mineralocorticoid or glucocorticoid.

9-3. Given the name of the primary mineralocorticoid or glucocorticoid and a group of statements, select the statement that describes the physiological function of that hormone.

9-4. Given a group of statements, select the statement that best describes the effects of either a hyposecretion or hypersecretion of either mineralocorticoids or glucocorticoids.

9-5. From a group of statements, select the statement that describes Addison's disease or Cushing's disease.

9-6. From a list of medical conditions, select the condition associated with the long-term administration of therapeutic amounts of glucocorticoids.

9-7. Given the trade and/or generic name of a specific adreno-cortical hormone or synthetic agent and a group of uses, side effects, patient precautionary statements, or cautions and warnings, select the use(s), side effect(s), patient precautionary statement(s), or caution(s) and warning(s) associated with the given agent.

9-8. Given the trade or generic name of a specific adrenocortical hormone or synthetic agent and a group of trade and/or generic names of medications, select the trade or generic name corresponding to the given name.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 9

ADRENOCORTICAL HORMONES

Section I. OVERVIEW

9-1. INTRODUCTION

The adrenocortical hormones are a group of chemical substances produced by the adrenal glands (suprarenal glands). These hormones are of particular importance to the body because they perform a variety of essential physiological functions. This lesson will review the physiology of these hormones and discuss some medications you have probably dispensed from your pharmacy.

9-2. THE ADRENAL GLANDS (SUPRARENAL GLANDS) AND THEIR PRODUCTS

Embedded in the fat above each kidney is an adrenal (suprarenal) gland. Both adrenal glands have an external portion and an internal portion. The external portion of the adrenal gland is called the cortex, while the internal portion of the gland is called the medulla. Both the cortex and the medulla produce specific hormones that are essential to the proper functioning of the body. As you will recall (Lesson 6, para 6-10a), the medulla produces epinephrine and norepinephrine. Epinephrine and norepinephrine are involved in the mobilization of energy during the stress reaction ("fight or flight" response). The cortex also produces hormones that are essential to the body. These hormones are introduced below.

9-3. HORMONES PRODUCED BY THE CORTEX OF THE ADRENAL GLANDS

The cortex of the adrenal gland produces hormones that can be grouped into three major groups of substances based on what they do in the body:

a. **Mineralocorticoids.** These hormones serve to control the electrolytes' potassium, sodium, and chloride in the body.

b. **Glucocorticoids.** These hormones serve to affect the metabolism of fat, glucose, and protein in the body.

c. **Androgens.** These hormones produce masculinizing effects in the body.

NOTE: This lesson will focus on the mineralocorticoids and glucocorticoids.

9-4. THE MINERALOCORTICOIDS

As stated above, the mineralocorticoids control the balance of potassium, sodium, and chloride in the body. The cortex secretes several different types of mineralocorticoids. The principal mineralocorticoid is aldosterone, since aldosterone is responsible for over 90 percent of the total mineralocorticoid activity.

a. **Physiological Actions of Aldosterone.** Aldosterone acts to increase the amount of sodium reabsorbed by the renal tubular epithelium. That is, the more aldosterone secreted by the cortex, the more sodium that is reabsorbed into the blood. Conversely, when extremely small amounts of aldosterone are secreted, very small amounts of sodium are reabsorbed into the blood and passed out of the body in the urine. Such control of sodium is crucial to the physiological balance in the body. Remember that sodium is the primary electrolyte in extracellular fluid. If there is too little sodium reabsorbed into the blood, the volume of extracellular fluid (and circulating blood volume) in the body could decrease to levels that could injure the body. Therefore, aldosterone helps to control the level of sodium in the body. In addition, aldosterone helps to decrease the amount of potassium reabsorbed (and thus increases the amount of potassium removed from the body in the urine) and increase the amount of chloride reabsorbed into the blood. To summarize, aldosterone helps to increase the amount of sodium and chloride present in the extracellular fluid and to decrease the amount of potassium present in the extracellular fluid.

b. **Hyposecretion of Mineralocorticoids.** As stated, hyposecretion of aldosterone can result in a lack of water in extracellular fluid (due to decreased amounts of sodium in the extracellular fluid). This can lead to decreased blood volume that can result in decreased cardiac output and hypotension.

c. **Hypersecretion of Mineralocorticoids.** Hypersecretion of mineralocorticoids (aldosterone) can lead to increased sodium reabsorption. This can also lead to decreased reabsorption of potassium into the blood. Ultimately, hypersecretion of aldosterone can result in an increased volume of extracellular fluid, which leads to increased volume of blood. This can increase cardiac output, ultimately resulting in hypertension.

9-5. THE GLUCOCORTICOIDS (HYDROCORTISONE (CORTISOL) AND OTHERS)

As stated previously, the glucocorticoids affect the metabolism of fat, glucose, and protein in the body. The principal glucocorticoid is hydrocortisone (cortisol).

a. **Physiological, Actions of the Glucocorticoids.** The glucocorticoids regulate blood/brain glucose levels. They also inhibit the inflammatory process. The glucocorticoids also decrease the immunological responses of the body by decreasing antibody formation. About 90 percent of the glucocorticoids produced is hydrocortisone (cortisol). One of the most significant metabolic actions of glucocorticoids is gluconeogenesis. Gluconeogenesis involves the formation of glycogen or glucose from noncarbohydrates such as fat or protein. This, of course, can act to raise the concentration of glucose in the blood. Glucocorticoids can also raise the concentration of glucose in the blood by decreasing the use of glucose by skeletal muscle. Glucocorticoids play an important role in the body's reaction to stress, although the specific mechanism for this role is not understood. Glucocorticoids also pay an important role as anti-inflammatory agents. As anti-inflammatory agents, they decrease the ability of histamine to dilate blood vessels, decrease the permeability of capillaries, impair the movement of phagocytes, and cause atrophy of lymphoid tissue (which causes a decrease in circulating antibodies).

b. **Hyposecretion of Glucocorticoids.** A decrease in circulating glucocorticoids often results in anemia, since the glucocorticoids have some effect on the production of red blood cells.

c. **Hypersecretlon of Glucocorticoids.** An increase in the production of glucocorticoids can produce a number of serious effects. One such effect is osteoporosis, a thinning and weakening of bone. A second effect is the moon face and the buffalo hump, a condition characterized by atypical disposition of fat in the shoulder areas (buffalo hump) and in the face (moon face). A third effect is increased susceptibility to infection due to the anti-inflammatory action of the glucocorticoids.

9-6. ABNORMALITIES OF ADRENAL FUNCTIONING

In most individuals, the adrenal glands function as they should. That is, they produce the hormones needed in the body in the required amounts. However, for one reason or another, some persons find their adrenal glands not functioning as they should. Two such conditions are presented below:

a. **Addison's Disease.** Addison's disease results when the adrenal glands secrete too little of its hormones into the individual's system. Addison's disease is characterized by fatigue, muscle weakness, weight loss, low blood pressure, and gastrointestinal upset.

b. **Cushing's Disease.** Cushing's disease results when the adrenal glands secrete too great a quantity of its hormones into the patient's system. Cushing's disease is characterized by atypical disposition of fat in the face (referred to as moon face), in the shoulder areas (referred to as buffalo hump), edema, hypertension, acne, and diabetes mellitus.

Section II. GLUCOCORTICOIDS AND SYNTHETIC AGENTS

9-7. INTRODUCTION

In this section, you will be provided with information related to agents that can be classified as either mineralocorticoids or glucocorticoids.

9-8. ADRENOCORTICAL SUPPRESSION WITH GLUCOCORTICOID AGENTS

The long-term administration of therapeutic amounts of glucocorticoids may result in adrenocortical suppression. This adrenocortical suppression occurs because the therapeutic levels of the synthetic glucocorticoids tend to suppress the release of adrenocorticotropic hormone (ACTH) from the pituitary gland via a negative feedback mechanism. This negative feedback mechanism results in the suppression of secretion and synthesis of the naturally occurring glucocorticoids of the adrenal cortex. Prolonged suppression may cause the adrenal cortex to atrophy, thus resulting in adrenocortical insufficiency upon discontinuation of glucocorticoid therapy.

9-9. CLINICAL INDICATIONS FOR GLUCOCORTICOIDS

The glucocorticoids have specific indications for use in the treatment of certain conditions. These indications are discussed below:

a. **Replacement Therapy.** The glucocorticoids are used in replacement therapy for several conditions. These include:

(1) Chronic adrenal insufficiency (Addison's Disease). Addison's disease may develop as a result of adrenal surgery or due to destructive lesions of the adrenal cortex. The replacement therapy associated with this condition requires approximately 20 to 30 milligrams of hydrocortisone (cortisol) or its equivalent daily, with increased amounts of medication during periods of stress. (NOTE: Doses as high as 100 milligrams of hydrocortisone per day may be necessary during periods of stress.) Furthermore, mineralocorticoid therapy will also be necessary with monthly injections of deoxycorticosterone (Doca®, Percorten®).

(2) Acute adrenal insufficiency. Acute adrenal insufficiency is usually associated with disorders of the adrenal cortex. Acute adrenal insufficiency frequently follows abrupt withdrawal of high doses of corticosteroids (adrenocortical steroids). Patients who present with acute adrenal insufficiency are usually administered large doses of hydrocortisone (Solu-Cortef®).

(3) Congenital adrenal hyperplasia syndrome (CAH). In CAH, the production of hydrocortisone (cortisol) and, at times, aldosterone is interfered with or prevented due to an inherited enzyme deficiency. The treatment of CAH requires the administration of hydrocortisone. The dosage of this agent must be adjusted over a long course of therapy to permit linear growth in children.

b. **Therapeutic Uses of Glucocorticoids in Nonendocrine Diseases.** The glucocorticoids are commonly used in the treatment of a variety of nonendocrine disorders. These products are useful because they produce anti-inflammatory and anti-immunologic actions in the body. The effects produced by these agents are seen with pharmacologic doses. Thus, patients who receive systemic glucocorticoid therapy for nonendocrine disorders risk developing adverse effects (such as moon face and buffalo hump, increased susceptibility to infection, etc.) associated with excessive levels of these substances. Glucocorticoids are used to treat the following disorders:

(1) Treatment of inflammatory diseases such as rheumatoid arthritis, osteoarthritis (degenerative joint disease), and rheumatic carditis.

NOTE: Pharmacologic doses of glucocorticoids are not curative, but rather they help improve the symptoms associated with these various diseases.

(a) Rheumatoid arthritis. Optimal therapy for patients who have only one or two joints afflicted with rheumatoid arthritis is 20 to 25 milligrams of hydrocortisone administered by intra-articular injection. More advanced cases of this disease require 5 to 20 milligrams of triamcinolone or 10 milligrams of prednisone orally in divided doses.

(b) Osteoarthritis (degenerative joint disease). Patients with osteoarthritis are sometimes administered 20 to 25 milligrams of hydro-cortisone by intra-articular injection. This administration should be done infrequently because of dissolvement of joints.

(c) Rheumatic joints. The administration of glucocorticoids in patients who have rheumatic carditis is reserved for patients who fail to respond to salicylates in life-threatening situations. Prednisone, 40 milligrams, is given orally in divided daily doses as treatment in these instances.

(2) Treatment of inflamed joints, tendons, bursae, and soft tissues. These conditions are treated locally with hydrocortisone injections.

(3) Treatment of renal disease. Prednisone, 80 to 120 milligrams, is given daily in oral doses to people who have nephrotic syndrome due to primary renal disease. Prednisone has little or no effect in acute or chronic glomerulonephritis.

(4) Treatment of collagen disease. An example of a collagen disease is systemic lupus erythematosus. Manifestations of collagen disease are well controlled by glucocorticoids that help to decrease morbidity and prolong survival time. Prednisone, 80 to 120 milligrams, is given orally for two to three weeks in the treatment of these conditions.

(5) Treatment of allergic disease. Glucocorticoids suppress manifestations of allergic disease, they inhibit inflammation and antibody production.

(6) Treatment of bronchial asthma. Hydrocortisone may be administered to patients with bronchial asthma in order to provide them with dramatic relief. However, the use of hydrocortisone is usually reserved for patients who have not been responsive to other anti-asthmatic drugs due to the side effects associated with glucocorticoid therapy.

(7) Treatment of various skin disorders. Many patients with noninfective skin disorders (such as allergic, inflammatory, or pruritic dermatosis) experience remarkable relief of symptoms with topical use of steroids. Topical use of these drugs is of benefit in severe sunburn, nonvenomous insect bites, and self-limiting cutaneous conditions such as eczema.

(8) Treatment of malignancies. Glucocorticoids are used in conjunction with other chemotherapeutic agents in the treatment of acute lymphocytic leukemia and lumphomas because of their anti-lymphocytic effect.

(9) Treatment of septic shock. The use of corticosteroids in septic shock has been adopted by most physicians and is used in very large doses early in the treatment of shock. Their beneficial effect appears to be related primarily to their action on cellular membranes. That is, they decrease the patient's reaction to septic, endotoxin, or hemorrhagic shock.

9-10. ADVERSE EFFECTS ASSOCIATED WITH GLUCOCORTICOID THERAPY

As with any medication, patients taking glucocorticoids should anticipate certain adverse effects. The likelihood of such adverse effects correlates with the dose of the drug and the duration of therapy, the age and condition of the patient, and the underlying disease. This paragraph will focus on the common adverse effects associated with glucocorticoid therapy.

a. **Peptic Ulceration.** The glucocorticoids are said to produce peptic ulceration by interfering with tissue repair, decreasing the protection provided by the gastric mucus barrier, and increasing gastric acid and pepsinogen production. Physicians do not all agree that glucocorticoid therapy causes peptic ulcers. However, they do agree that glucocorticoid therapy can hide the symptoms of peptic ulcers so that ulceration or bleeding can occur without warning pains. Some physicians prescribe antacids in hopes of reducing the likelihood of peptic ulcers in patients on glucocorticoid therapy. It

is known that antacids can decrease the amount of glucocorticoids absorbed, especially if small doses of the glucocorticoids are administered.

b. **Hypokalemic Alkalosis and Edema.** As you will recall, mineralocorticoids increase the absorption of sodium into the blood (thus less sodium leaves the body in the urine) and decrease the reabsorption of potassium into the blood (thus more potassium leaves the body in the urine). Thus, the patient who continues to ingest his normal amount of sodium per day may find himself with edema (where sodium goes, it takes water) and hypokalemia (more sodium stays in and makes more potassium leave the body) if he is taking glucocorticoids.

c. **Iatrogenic Cushing's Syndrome.** As you will recall, Cushing's disease results from hypersecretion of the adrenal glands. With iatrogenic Cushing's syndrome, the excessive amounts of glucocorticoids present in the body can be attributed to the medications the patient is taking. As you might expect, the same signs will be seen in both types of patients, moon face, buffalo hump, edema, hypertension, etc.

d. **Diabetes Mellitus.** Persons taking glucocorticoids may find that their diabetes is aggravated because of the glucocorticoid therapy. Also, the glucocorticoids may make patients with latent diabetes into diabetics.

e. **Moon Face and Buffalo Hump.** These conditions, which are also found in persons who suffer from hypersecretion of the adrenal glands, are also found in some people who are administered glucocorticoids. See paragraph 9-6b for a review of this topic,

f. **Osteoporosis.** This adverse effect is associated with the long-term administration of large doses of these agents. Essentially, the gluco-corticoids suppress the formation of bone and inhibit the absorption of calcium from the gastrointestinal tract.

g. **Adrenal Insufficiency.** When therapeutic amounts of glucocorticoids are given for long periods of time, adrenocortical suppression occurs because therapeutic levels of glucocorticoids tend to suppress the release of adrenocorticotropin (ACTH) from the pituitary gland through negative feedback. See paragraph 9-9 for further discussion.

h. **Increased Susceptibility to Infection.** Persons taking glucocorticoids find themselves to be susceptible to infection, especially tuberculosis, bacterial infections of the skin, and fungal or yeast infections. Of real concern is the fact that glucocorticoids tend to mask infections. Thus, infections can become severe before they are recognized.

i. **Central Nervous System Effects.** Persons taking large doses of glucocorticoids can undergo personality and behavioral changes that are usually

manifested by euphoria. These persons may also be unable to sleep (insomnia), have increased appetite, be nervous or irritable, and be hyperactive.

j. **Growth Suppression.** Growth is suppressed in children who receive long-term administration of glucocorticoids in daily, divided doses. Hence, such therapy should be restricted to children who must receive that type of therapy.

k. **Posterior Subcapsular Cataract Formation.** This type of cataract formation is associated with prolonged systemic glucocorticoid therapy and it appears to be dose-related (e.g., 20 milligrams of Prednisone taken orally for several years). Children are more frequently affected with this adverse effect than are adults.

9-11. CAUTIONS AND WARNINGS ASSOCIATED WITH GLUCOCORTICOID THERAPY

The following cautions and warnings are associated with glucocorticoid therapy:

a. Glucocorticoid therapy should be used with the greatest caution in patients who have the following disorders:

(1) Peptic ulcers.

(2) Diabetes mellitus.

(3) Osteoporosis.

(4) Active infections.

b. Glucocorticoid therapy should be used with caution in patients who have inactive tuberculosis. (It has been shown that reactivation of tuberculosis can occur in patients who take glucocorticoids.)

c. Adrenocortical insufficiency can be avoided in patients who are on long-term glucocorticoid therapy by keeping the dosage as low as possible and by using intermittent dosage (i.e., taking the drug every other day) when possible.

d. Abruptly stopping prolonged glucocorticoid therapy should be avoided since this may precipitate acute adrenal insufficiency.

e. All patients who have been on glucocorticoid therapy within four to six months prior to surgery should be given supplemental doses of glucocorticoids (e.g., 200 milligrams of hydrocortisone a day before surgery and 100 milligrams of hydrocortisone intravenously at the time of surgery).

f. The prolonged administration of glucocorticoids in children should be restricted to the most urgent indications due to the adverse effects associated with these agents.

g. Topical glucocorticoids should not be applied to open cuts or wounds because of possible systemic absorption of the drugs.

h. Viral vaccinations should be avoided by patients who are on glucocorticoid therapy.

9-12. GLUCOCORTICOID PREPARATIONS

a. **Hydrocortisone (HC, Solu-Cortef®).** Hydrocortisone has a high level glucocorticoid activity and a moderate level of mineralocorticoid activity. It is the drug preferred for replacement therapy in acute or chronic adrenocortical insufficiency and in forms of congenital adrenal hyperplasia. This drug is available in oral, parenteral, and topical dosage (e.g., dental paste).

b. **Prednisone (Deltasone®).** Prednisone is a form of cortisone that is available in parenteral and oral dosage forms. This agent is used primarily in the treatment of inflammatory conditions, stress, or trauma. Prednisone has a high level of glucocorticoid activity and a low level of mineralocorticoid activity. Hence, this agent is not suitable to use as the only agent in treating patients who need drugs with sufficient mineralocorticoid activity.

c. **Methylprednisolone Sodium Succinate (Solu-Medrol®).** This agent has a high level of glucocorticoid activity and a low level of mineralocorticoid activity. It is used in inflammatory and allergic conditions. Methylprednisolone is available in oral and parenteral forms for systemic effects and in cream form for the local effects.

d. **Dexamethasone (Decadron®, Hexadrol®).** Dexamethasone is a derivative of methylprednisolone (a substance similar to prednisone) which is used primarily in inflammatory or allergic conditions. Dexamethasone is available in inhalation, oral, and injectable dosage forms. This drug has a high level of glucocorticoid activity and a low level of mineralocorticoid activity.

e. **Triamcinolone (Aristocortv, Kenalog®).** Triamcinolone has a high level of glucocorticoid activity and a slight level of mineralocorticoid activity. This product is available in oral and parenteral dosage forms for systemic effects and in various types of topical dosage forms for local effects.

9-13. TOPICAL PREPARATIONS

a. **Bethamethasone (Valisone®).** This product has a high level of glucocorticoid activity and a slight level of mineralocorticoid activity. It is available in

cream, lotion, gel, and ointment dosage forms for topical administration. This drug is used in the treatment of various skin disorders (not open wounds).

b. **Flucinolone (Synalar®).** This product is available in cream, ointment, and solution topical dosage forms.

c. **Fluocinonide (Lidex®).** This product is available in cream, ointment, and tape dosage forms.

d. **Flurandrenolide (Cordran®).** This product is available in cream, lotion, ointment, and tape dosage forms for topical application.

e. **Halcinonide (Halog®).** This product is available in cream, ointment, and solution dosage forms for topical application.

9-14. RELATIVE POTENCIES OF SYSTEMIC ADRENOCORTICAL STERIODS

Table 9-1 below compares some of the systemic adrenocortical steroids in the areas of anti-inflammatory potency, sodium retaining potency, and equivalent dose. This chart allows you to compare some of the most commonly used adrenocortical steroids in these important areas.

Compound	Anti-Inflammatory Potency	Sodium Retaining Potency	Equivalent Dose
Hydrocortisone (Cortisol)	1	1	20.0 mg
Cortisone	0.8	0.8	25.0 mg
Deoxycorticosterone	0.0	100	-
Aldosterone	0.0	3000	-
Prednisone	4	0.8	5.0 mg
Methylprednisolone	5	0.8	4.0 mg
Triamcinolone	5	0.0	4.0 mg
Dexamethasone	30	0.0	0.75 mg

Table 9-1. Comparison of systemic adrenocortical steroids.

Continue with Exercises

EXERCISES, LESSON 9

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Which of the following hormones are produced by the cortex of the adrenal gland?

   a. Androgens, mineralocorticoids, and glucocorticoids.

   b. Estrogen, aldosterone, and insulin.

   c. Testosterone, aldosterone, and cortisone.

   d. Aldosterone, cortisone, and insulin.

2. The principle glucocorticoid is:

   a. Aldosterone.

   b. Insulin.

   c. Thyroid.

   d. Hydrocortisone.

3. What is the predominant physiological function of hydrocortisone (cortisol)?

   a. Forming glucose from nonglucose factors.

   b. Increasing the reabsorption of sodium in the kidney.

   c. Increasing the concentration of potassium in perspiration.

   d. Decreasing the reabsorption of sodium in the kidney.

4. A decrease in the amount of mineralocorticoids in the blood can result in:

    a. Hypertension.

    b. Diabetes mellitus.

    c. Hypotension.

    d. Cushing's disease.

5. Cushing's disease is caused by:

    a. Hypersecretion of hormones by the adrenal glands.

    b. Hyposecretion of hormones by the adrenal glands.

    c. Hyposecretion of glucocorticoids.

    d. Hyposecretion of mineralocorticoids.

6. What is the condition associated with the long-term administration of therapeutic amounts of glucocorticoids?

    a. Hypothyroidism.

    b. Adrenocortical suppression.

    c. Hypertension.

    d. Diabetes mellitus.

7. Betamethasone is used in the treatment of:

    a. Systemic bacterial infections.

    b. Skin disorders (not open wounds).

    c. Systemic mycotic (fungal) infections.

    d. Tuberculosis.

8. One of the side effects associated with the use of glucocorticoids is:

   a. Weight loss.

   b. Buffalo face.

   c. Severe diarrhea.

   d. Edema (swelling of the feet or lower legs).

9. Deltasone® is used in the treatment of:

   a. Inflammatory conditions.

   b. Peptic ulcers.

   c. Acne.

   d. Cushing's disease.

SPECIAL INSTRUCTIONS FOR EXERCISES 10 THROUGH 13. In exercises 10 through 13, match the trade name listed in Column B with its corresponding generic name listed in Column A.

Column A	Column B
10. ___ Flurandrenolide	a. Kenalog®
11. ___ Prednisone	b. Deltasone®
12. ___ Triamcinolone	c. Cordran®
13. ___ Hydrocortisone	d. Solu-Cortef®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 9

1. a (para 9-3)
2. d (para 9-5a)
3. a (para 9-5a)
4. c (paras 9-4a, b)
5. a (para 9-6b)
6. b (para 9-8)
7. b (para 9-13a)
8. d (para 9-10b)
9. a (para 9-12b)
10. c (para 9-13d)
11. b (para 9-12b)
12. a (para 9-12e)
13. d (para 9-12a)

End of Lesson 9

LESSON ASSIGNMENT

LESSON 10	Insulin and Oral Hypoglycemic Agents.
LESSON ASSIGNMENT	Paragraphs 10-1 through 10-22.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

10-1. From a group of statements, select the statement that best describes why insulin is not therapeutically effective when it is administered orally.

10-2. From a group of statements, select the statement that describes the role of insulin in the physiological processes of the body.

10-3. Given the names of particular sites in the body, select the site at which insulin is produced.

10-4. From a group of statements, select the statement that describes how the level of insulin in the blood is regulated.

10-5. Given a group of statements, select the statement that describes diabetes mellitus.

10-6. From a group of conditions, select the condition(s) that are complications associated with diabetes mellitus.

10-7. From a list of signs and/or symptoms, select the sign(s) and/or symptom(s) that can indicate the presence of diabetes mellitus.

10-8. Given the name of a clinical test for discovering/ monitoring diabetes mellitus and a group of statements, select the statement that describes that clinical test.

10-9. Given the name of a basic type of diabetes mellitus, select the statement that describes that type or its treatment.

10-10. Given a group of concentrations, select the concentrations in which insulin is typically available.

10-11. From a group of statements, select the statement that best describes the use or storage of insulin preparations.

10-12. Given the trade, generic, or commonly used name of an insulin product and a group of use(s), onsets of action, duration of action, or precautionary statements, select the use(s), onset of action, duration of action, or precautionary statement associated with the given agent.

10-13. Given one of the following conditions: hypoglycemia or hyperglycemia and a group of statements, select the statement that describes the cause, signs and/or symptoms, or treatment for the given condition.

10-14. From a group of statements, select the statement that describes the mechanism of action of the oral hypoglycemics.

10-15. Given the names of several chemical substances, select the substance(s) likely to interact with oral hypoglycemics.

10-16. Given the trade and/or generic name of an oral hypoglycemic agent and a group of uses, side effects, and cautions and warnings, select the use(s), side effect(s), or caution(s) and warning(s) associated with the given agent.

10-17. Given the trade, generic, or commonly used name of an insulin product or hypoglycemic agent and a group of trade, generic, or commonly used names of drugs, select the trade, generic, or commonly used name that corresponds to the given drug name.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 10

INSULIN AND THE ORAL HYPOGLYCEMIC AGENTS

Section I. PHYSIOLOGY OF INSULIN

10-1. INTRODUCTION

There are an estimated 11 million individuals in the United States who have diabetes mellitus. Many of these persons are authorized care in Army medical treatment facilities. Because of this, you will be dispensing insulin or oral hypoglycemic agents to these patients. The medications you dispense will not "cure" diabetes, but the medications will make it possible for these diabetics to live a more normal life.

10-2. HISTORY OF INSULIN

The existence of insulin has been known for many years. As early as 1889, scientists were aware of the fact that the surgical removal of an animal's pancreas resulted in that animal's having signs similar to those associated with human diabetes mellitus. In 1922, a human suffering from diabetes mellitus was successfully treated with a hormonal product known as insulin. Since that time, insulin has been obtained from the pancreases of slaughtered animals. Such insulin has allowed the millions of persons who use insulin to continue living. Today, breakthroughs in genetic engineering have resulted in an insulin exactly like that of humans. This new insulin is called Humulin®.

10-3. THE CHEMICAL INSULIN

Insulin is a chemical substance. It consists of 51 amino acids connected in two chains. Because of its chemical composition, insulin is inactivated by digestive enzymes. Therefore, it cannot be taken orally, it must be administered by injection.

10-4. ACTIONS OF INSULIN

Insulin is an enzyme. That is, it is a chemical catalyst that enhances the processes by which the tissues of the body use glucose. Insulin impacts both the use of glucose as fuel for the tissues and the storage of glucose (with as glycogen or as fat). Therefore, the key word is energy. Specifically, insulin affects metabolism by increasing the use and decreasing the production of glucose, increasing the storage and decreasing the production and oxidation of fatty acids, and increasing the formation of protein.

10-5. PRODUCTION OF INSULIN IN THE BODY

a. Insulin is produced and stored in the beta cells of the Islets of Langerhans of the pancreas. Insulin is released from storage in the pancreas into the bloodstream.

b. The level of glucose in the blood is the primary regulator of the secretion of insulin into the bloodstream. When an individual has not eaten in a long while, the level of insulin in the blood is at a minimum. Also, some gastrointestinal hormones (i.e., cholecystokinin, gastrin, and secretin) and amino acids stimulate insulin secretion. After the person ingests food, a combination of the presence of amino acids, glucose, and gastrointestinal hormones acts to stimulate insulin secretion and raise the level of insulin in the blood. While the level of insulin in the blood is high, the body uses the glucose in the blood for energy and it converts excess glucose to fat for future energy needs.

10-6. CONDITIONS DUE TO ABNORMAL AMOUNTS OF INSULIN IN THE BLOODSTREAM

The body requires a certain amount of insulin to be present in the blood when the insulin is needed. Although the level of insulin in the blood does not remain the same over a 24-hour period, insulin must be present in the blood at all times. The individual whose pancreas produces and releases insulin in the required amount at the time it is needed is fortunate indeed. However, not all persons are this fortunate. Diabetes mellitus is a disorder resulting from inadequate production or use of insulin. If, on the other hand, a patient has too high a level of insulin--due to the administration of too much insulin or lack of food after the administration of insulin--the patient's life can be in danger. These two conditions are discussed in the following section.

Section II. CONDITIONS DUE TO ABNORMAL AMOUNTS OF INSULIN IN THE BLOODSTREAM

10-7. DIABETES MELLITUS

a. **Description.** Diabetes mellitus is a disorder characterized by hyperglycemia (high levels of glucose In the blood) and glycosuria (glucose in the urine) resulting from inadequate production or use of insulin.

b. **Significance.** Over 10 million persons in the United States have diabetes mellitus. Diabetes mellitus affects both young and old alike. Insulin and oral hypoglycemic agents have helped prolong the life of persons who have diabetes mellitus. However, persons who have diabetes mellitus, even though it is successfully treated, sometimes have complications. Remember, diabetes mellitus can be treated, but it cannot be cured with the administration of either insulin or oral hypoglycemics. The complications most often associated with diabetes mellitus include blindness. Such blindness can result from several causes. Diabetic retinopathy, one of those causes of blindness, occurs because of the deterioration of the blood vessels in the eye.

Cataract formation is another complication associated with diabetes mellitus. It is theorized that such cataract formation occurs because of increased levels of sorbital in the lens of the eye.

c. **Signs of Diabetes Mellitus.** Fortunately, there are some signs that can indicate the presence of diabetes mellitus. Some of these signs are listed and discussed below. Remember, if you believe that you or any person you know has diabetes, you should contact a physician as soon as possible for professional evaluation.

(1) Polyuria. Polyuria means increased urine output. In diabetics, polyuria is caused by high level of glucose present in the blood. Since the glucose cannot be transferred into the cells of the body, the glucose increases in concentration in the blood. The glucose produces diuresis because it acts as an osmotic diuretic. Hence, output of urine is increased.

(2) Polydipsia. Polydipsia means increased thirst. The thirst is produced by the excessive level of glucose in the blood and the movement of fluids from the cells into the blood in an attempt to dilute the glucose concentration.

(3) Polyphagia. Polyphagia means increased appetite. This polyphagia is caused by the cell's need for glucose. Although the concentration of glucose in the blood might be extremely high, the lack of insulin means that the cells cannot use that glucose.

(4) Hyperglycemia. Hyperglycemia refers to higher than normal levels of glucose in the blood. The normal level of glucose in the blood is 60 to 100 milligrams per 100 milliliters. Of course, the level of glucose will increase after the ingestion of food.

(5) Glucosuria. Glucosuria refers to the presence of glucose in the urine. Glucose is in the urine because it is in high levels in the blood and is removed from the blood in the kidneys (see para 10-7c(1) above).

d. **Clinical Tests for Discovering and Monitoring Diabetes.** Suppose you think you have diabetes mellitus. Perhaps you have been drinking more fluids than usual. Perhaps you have more urine output than in the past. How can a person determine if he/she has diabetes mellitus? Fortunately, tests are available that can help the physician to determine whether or not a person has diabetes. The glucose tolerance test is given under controlled conditions under the direction of a physician to determine if a person has diabetes. After the diagnosis of diabetes mellitus has been confirmed, the physician will prescribe insulin or some oral hypoglycemic agent as a treatment for the condition. Even then, the level of glucose in the blood must be monitored periodically. The methods below can be used by the diabetic in the home to monitor glucose levels in the patient's body.

(1) Tes-Tape® (Glucose Enzymatic Test Strip). Tes-Tape® measures the presence of glucose in the urine. Shades in the color of the strip after it has been dipped in urine can be compared with colors printed on the package. Each color corresponds to a known concentration of glucose in urine. Although Tes-Tape® results are not as precise as those which can be obtained in a laboratory, the tester can obtain a general idea of how much glucose is present in the urine. Such information can be valuable to the physician.

(2) Dextrostix® (reagent strips). Dextrostix® is a product that is used to determine the level of glucose in the blood. Fingertip or venous blood is applied to the strip. Later, the color of the strip is compared to colors on the package label. Each color corresponds to a particular level of glucose in the blood.

(3) N-Multistix® (reagent strips). N-Multistix® is a product used for the determination of protein, glucose, ketones, bilirubin, occult blood, urobilinogen, and nitrite in the urine.

(4) Diastix® (reagent strips). Diastrix® is a product that is used in the determination of glucose in the urine. Color comparison charts show the level of glucose.

(5) Keto-Diastix® (reagent strips). Keto-Diastix® is a product used in the determination of ketones and glucose in the urine. Color comparison charts show the level of glucose and ketones in the urine.

(6) Dextrometer™ (reflectance colorimeter with digital display). This product is a machine that can be used with Dextrostix® reagent strips to determine precisely the level of glucose in the blood. The readings from the machine help the person to monitor their diet and insulin intake to a greater degree.

10-8. TYPES OF DIABETES MELLITUS

There are two basic types of diabetes mellitus: juvenile-onset and maturity-onset. Both these types of diabetes are thought to occur in persons who have inherited a predisposition to the condition. It is thought, also, that juvenile-onset diabetes is initiated by viral infections of a certain kind (like German measles and mumps). Remember, the type of diabetes does not depend on the age of the patient.

a. **Type I Diabetes Mellitus (Juvenile-Onset Diabetes) (Acute-Onset Diabetes).** Juvenile-onset diabetes results from an insufficient secretion of insulin from the pancreas. This type of diabetes begins suddenly (i.e., acute onset). Furthermore, the symptoms associated with diabetes mellitus appear quite suddenly in juvenile-onset diabetes. Persons who have juvenile-onset diabetes mellitus must use insulin injections to control the diabetes.

b. **Type II Diabetes Mellitus (Maturity-Onset Diabetes).** Maturity-onset diabetes mellitus results from an individual's reduced sensitivity to the effects produced by insulin. Maturity-onset diabetes is characterized by the slow onset of symptoms and signs associated with diabetes. Maturity-onset diabetes can often be controlled by requiring the patient to follow a strict diet plan. Oral hypoglycemic agents are also used in the treatment of this condition.

Section III. TREATMENT OF DIABETES MELLITUS BY INSULIN THERAPY

10-9. INTRODUCTION

As previously mentioned (see para 10-8), insulin is essential in the treatment of juvenile-onset diabetes mellitus. Insulin has been successfully used in the treatment of juvenile-onset diabetes since 1922. Typically, a person with juvenile-onset diabetes mellitus must remain on insulin therapy for the remainder of the lifespan. As a person who works in the pharmacy, you must be familiar with the different types of insulin and topics of interest associated with insulin therapy.

10-10. SOURCES OF INSULIN

a. Insulin is primarily obtained from the pancreases of slaughtered beef cattle and pigs. Hence, it is labeled "beef" or "pork" depending on the source of the pancreases. Insulin you have in the pharmacy consists of either a mixture of pork or beef insulin or single-source products (i.e., insulin prepared either from beef or pork pancreases). The information specific to the source of the insulin is contained on the product label. The mixture products are usually dispensed. However, when a patient has been taking either pork or beef insulin, the source should not be switched.

b. A new type of insulin, Humulin®, has begun being used by some diabetics. This new product is made by bacteria and by chemical alteration of pork insulin. Interestingly, this type of insulin is very similar to human insulin.

10-11. MEASUREMENT OF INSULIN

a. You know that many medications have their concentrations expressed in terms of milligrams per milliliter or milligrams per tablet. Insulin is expressed in terms of units per milliliter. These units refer to the activity of the insulin.

b. Insulin preparations are most commonly supplied in two concentrations, 40 units per milliliter and 100 units per milliliter.

10-12. USE OF INSULIN PREPARATIONS

Most insulin preparations are suspensions. Therefore, the patient must ensure that the insulin is thoroughly mixed before the syringe and needle is used to remove it from the bottle. THE INSULIN BOTTLE MUST NOT BE SHAKEN BEFORE THE DOSE

IS EXTRACTED. If the bottle is shaken, air bubbles may be introduced into the product and the measured dose may be inaccurate (i.e., air bubbles are measured instead of insulin). To properly mix the insulin, the patient should roll the bottle slowly between the palms of the hands. Insulin bottles should be discarded when they contain lumps or visible grains of insulin or if the contents of the vial are discolored.

10-13. STORAGE OF INSULIN PREPARATIONS

Insulin preparations should be refrigerated, but they should not be frozen. Specifically, insulin preparations should be stored between two and 8^{o}C (36^{o} to 46^{o} F). Expiration dates should be examined to insure the product is in date when it is dispensed and used.

10-14. INSULIN SYRINGES

The patient should use only one brand or type of syringe to either mix or administer the insulin. Differences in brands or types of syringes (even those made by the same manufacturer) can mean the patient is receiving too little or too much insulin. This occurs because of the unmeasured volume of fluid between the bottom calibration on the syringe and the tip of the needle.

10-15. MIXING OF INSULIN TYPES

Depending on patient needs, some types of insulin may be mixed. Such mixing would, of course, be directed by the physician who deals with the patient. References (like the United States Pharmacopeia Dispensing Information) should be consulted to determine if such mixing is possible.

10-16. TYPES OF INSULIN

The various types of insulin you will encounter in your pharmacy are listed and discussed below:

a. **Insulin Injection (Regular Insulin, Crystalline Zinc Insulin).** Insulin injections may be given subcutaneously in the treatment of diabetic hyperglycemia and intravenously in the treatment of diabetic ketoacidosis. This product is available in the 40 and 100 unit strengths in a mixture of beef and pork insulin. The 100 unit strength is available as either beef or pork source. The onset of action of this product is from 30 minutes to one hour. The time required to reach the peak effect is from two to four hours. The duration of action of this product ranges from five to seven hours.

b. **Protamine Zinc Insulin Suspension (PZI Insulin).** This product is administered subcutaneously only. It is typically administered once a day, from 30 to 60 minutes before breakfast. The onset of action of this product is from four to six hours. The peak effect of PZI insulin is reached within four to six hours after administration. The duration of action of the preparation is approximately 36 hours.

c. **Insulin Zinc Suspension (Lente Insulin®).** This product is usually administered subcutaneously once a day. Most patients administer lente insulin approximately 30 to 60 minutes before breakfast. The onset of action of this preparation ranges from one to three hours. The time required for peak effect ranges from 8 to 12 hours. The duration of action of this product is from 24 to 28 hours.

d. **Prompt Insulin Zinc Suspension (Semilente®).** This product is administered subcutaneously. Typically, it is given once a day, 30 to 60 minutes before breakfast. The onset of action of Semilente® is from one to three hours. The time required for peak effect is from two to eight hours. The duration of action of this preparation is from 12 to 16 hours.

e. **Extended Insulin Zinc Suspension (Ultralente®).** This product is usually administered subcutaneously. It is usually given 30 to 60 minutes before breakfast. The onset of action of this product is from four to six hours. The time required to reach the peak effect is from 18 to 24 hours. The duration of action of Ultralente® is approximately 36 hours.

f. **Isophane Insulin Suspension (NPH Insulin®).** This product is usually administered subcutaneously once a day. It is typically given 30 to 60 minutes before breakfast. The onset of action of NPH Insulin is from three to four hours. The time required to obtain the peak effect ranges from 6 to 12 hours. The duration of action of NPH Insulin ranges from 24 to 28 hours.

g. **Globin Zinc Insulin Injection (Globin Insulin®).** This product is administered subcutaneously. It is usually administered once a day, from 30 to 60 minutes before breakfast. THIS PRODUCT IS NOT MIXED WITH OTHER INSULIN TYPES BECAUSE OF ITS pH. The onset of action of globin insulin is two hours. The time required for peak effect ranges from eight to 16 hours. The duration of action of this product is 24 hours.

h. **Isophane Insulin Suspension and Insulin Injection.** This product consists of 70 percent of isophane insulin suspension and 30 percent of insulin injection. The pork source is the only one available. This product is administered subcutaneously. Typically, it is administered once a day, 15 to 30 minutes before breakfast.

10-17. IRREGULARITIES OF INSULIN THERAPY

Theoretically, a person who has been prescribed insulin should have few problems with diabetes mellitus if food intake is controlled and if insulin administration is properly maintained. However, such control is easier said than done. Periods of stress (physical or mental in nature) can interfere with the delicate balance a diabetic has to maintain in order to function properly. If the diabetic ingests too much food (e.g., eats several pieces of candy at a holiday celebration), this delicate balance can be upset. Diabetics and their friends must be aware of potential difficulties associated with

diabetes mellitus. Hypoglycemia and hyperglycemia are two of these potential difficulties.

a. **Hypoglycemia ("Low Blood Sugar").** Hypoglycemia (also known as "low blood sugar" or "insulin reaction") results from an overdose of insulin or an oral hypoglycemic agent, from the too frequently administered insulin, from unaccustomed exercise, or from a delayed or skimpy meal. In other words, there is insufficient glucose present in the patient's blood. In this condition the diabetic speech becomes slurred and the patient appears to be intoxicated. It is critical that this condition be properly diagnosed by medical personnel. Hypoglycemia can be quickly treated. One, the diabetic can be given a source of energy (e.g., a teaspoonful of sugar or a candy bar) by mouth. Two, medical treatment personnel can administer glucagon injection, a product that acts on liver glycogen in order to convert the glycogen to glucose.

b. **Hyperglycemia ("Diabetic Coma").** Hyperglycemia ("diabetic coma" or acidosis) results from the patient's neglecting to maintain proper dieting habits, the patient's missing of required insulin doses, the patient's taking an underdose of insulin, or from the patient's taking the insulin in doses that are too far apart. Hyperglycemia can be treated with the administration of insulin. It is best that the patient's physician be made aware of the patient's condition as soon as possible. This is necessary because the patient's dosage of insulin might have to be changed.

Section IV. ORAL HYPOGLYCEMIC AGENTS

10-18. INTRODUCTION

In individuals with maturity-onset diabetes mellitus, it is sometimes not necessary to require the administration of insulin. Diet, in some instances can control the diabetes. In other cases, the patient might have to take oral hypoglycemic agents to control the diabetes mellitus. Oral hypoglycemic agents are not effective in the treatment of juvenile-onset diabetes mellitus.

10-19. MECHANISM OF ACTION OF ORAL HYPOGLYCEMIC AGENTS

The oral hypoglycemic agents are sulfonylurea derivatives. These agents do not increase the production of insulin in the beta cells of Islet of Langerhans. Instead, they increase the secretion of insulin from the beta cells. The mechanism of this effect is not known. Overall, the effect of these agents is to reduce the concentration of glucose in the patient's blood.

10-20. POSSIBLE DRUG INTERACTIONS

A person who is taking an oral hypoglycemic agent may experience nausea, vomiting, and abdominal pain (similar to that seen in disulfiram therapy) when alcohol is consumed. Furthermore, patients who are on oral hypoglycemic therapy should be

evaluated by their physicians when the patients are also taking propranolol, oxytetracycline, or coumarin-type anticoagulants.

10-21. DOSING INFORMATION

A person who is taking an oral hypoglycemic agent should maintain a diet suggested by the attending physician. Specifically, the patient should avoid "cheating" (eating too much food, eating sweets, etc.). Such "cheating" can interfere with the effectiveness of the treatment approach.

10-22. SPECIFIC ORAL HYPOGLYCEMIC AGENTS

a. **Acetohexamide (Dymelor®).** Acetohexamide is an oral hypoglycemic agent. Typically, the patient is given 250 milligrams a day initially and the dosage is gradually increased until the diabetes is controlled. Side effects associated with this agent include drowsiness, photosensitivity reactions, gastrointestinal upset, muscle cramps, and diarrhea. Patients taking this drug should be cautioned not to consume alcohol or to take other medications without the knowledge of the attending physician.

b. **Chlorpropamide (Diabinese®).** Chlorpropamide is an oral hypoglycemic agent that is sometimes used in other patients because of its antidiuretic effect. As with acetohexamide, the initial dosage of this drug (100 to 250 milligrams) is gradually increased until the desired effects are achieved. Side effects associated with this agent include drowsiness, gastrointestinal upset, muscle cramps, and water retention (antidiuretic effect). Patients taking this product should be cautioned not to consume alcohol or to take other medications without the knowledge of the attending physician.

c. **Tolazamide (Tolinase®).** Tolazamide is used as an oral hypoglycemic agent. Side effects associated with tolazamide include drowsiness, muscle cramps, and diarrhea. Patients taking this drug should be cautioned not to consume alcohol or to take other medications without the knowledge of the attending physician.

d. **Tolbutamide (Orinase®).** Tolbutamide is used as an oral hypoglycemic agent. Side effects associated with tolbutamide include drowsiness, muscle cramps, and diarrhea. Patients taking tolbutamide should be cautioned not to consume alcohol or to take other medications without the knowledge of the attending physician.

Continue with Exercises

EXERCISES, LESSON 10

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Insulin is not therapeutically effective when it is taken orally because:

   a. It is not absorbed because of its pH.

   b. It is changed to glycogen by the hydrochloric acid in the stomach.

   c. It is metabolized into fatty acids before it is absorbed.

   d. It is inactivated by digestive enzymes.

2. Which of the following are signs associated with diabetes mellitus?

   a. Decreased appetite and excessive thirst.

   b. The presence of glucose in the urine and excessive thirst.

   c. Lower than normal blood glucose levels and increased urine output.

   d. Increased appetite and lower than normal blood glucose levels.

3. Insulin is produced and stored in the beta cells of the:

   a. Gallbladder.

   b. Islets of Langerhans in the liver.

   c. Posterior ventrolateral nucleus of the thalamus.

   d. Islets of Langerhans in the pancreas.

4. The level of insulin in the blood is regulated by:

    a. The level of glucose in the blood.

    b. The level of cholecystokinin in the blood.

    c. The glucose-fatty acid feedback mechanism.

    d. The level of sucrose or glucose in the digestive system.

5. Diabetes mellitus is:

    a. A disease in which there is excessive production of insulin by the pancreas.

    b. A chronic condition caused by inadequate absorption of carbohydrates by the intestines.

    c. A disorder resulting from inadequate production or use of insulin.

    d. An illness characterized by hypoglycemia and glycosuria.

6. Which of the following are complications associated with diabetes mellitus?

    a. Decreased levels of sorbital in the lens of the eye.

    b. Hypertension.

    c. Diabetic retinopathy.

    d. Hypoglycemia.

7. A Dextrometer® can be used to:

    a. Determine the level of glucose in a person's blood.

    b. Determine the levels of glucose and ketones in the patient's urine.

    c. Determine the levels of protein, glucose, ketones, and biliruben in a patient's blood.

    d. Determine the level of occult blood present in a sample of urine.

8. Maturity-onset diabetes mellitus is described as:

    a. A condition caused by viral infections (like German measles and mumps) and characterized by hyperglycemia and polyuria.

    b. A condition which results from an individual's reduced sensitivity to the effects produced by insulin.

    c. A type of diabetes characterized by rapid onset of the signs of diabetes.

    d. A type of diabetes in which insulin is no longer produced in the body.

9. Juvenile-onset diabetes mellitus is treated by:

    a. Oral hypoglycemic agents.

    b. Strict diet plans.

    c. Surgery and strict diet plans.

    d. Injections of insulin.

10. Insulin is commonly available in the following concentrations.

    a. 10 units per milliliter and 50 units per milliliter.

    b. 40 units per milliliter and 100 units per milliliter.

    c. 50 units per milliliter and 100 units per milliliter.

    d. 100 units per milliliter and 250 units per milliliter.

11. The duration of action of PZI Insulin® is:

    a. 18 hours.

    b. 24 hours.

    c. 36 hours.

    d. 48 hours.

12. Hypoglycemia in a person who is taking insulin for diabetes mellitus can be treated by:

    a. Having the person eat a candy bar.

    b. Administering insulin to the person.

    c. Giving the person an oral hypoglycemic agent.

    d. Administering diphenhydramine (Benadryl®).

13. One side effect associated with Diabinese® is:

    a. Water retention.

    b. Hyperglycemia.

    c. Polyuria.

    d. Cataracts.

SPECIAL INSTRUCTIONS FOR EXERCISES 14 THROUGH 17. In exercises 14 through 17, match the trade (or commonly used) name listed in Column B with its corresponding generic name listed in Column A.

	Column A		Column B
14. _____	Chlorpropamide	a.	NPH insulin®
15. _____	Prompt Insulin Zinc Suspension	b.	Dymelor®
16. _____	Acetohexamide	c.	Diabinesev
17. _____	Isophane Insulin Suspension	d.	Semilente®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 10

1. d (para 10-3)
2. b (para 10-7c(2)(5))
3. d (para 10-5)
4. a (para 10-5b)
5. c (para 10-7a)
6. c (para 10-7b)
7. a (para l0-7d(6))
8. b (para 10-8b)
9. d (para 10-8a)
10. b (para 10-11b)
11. c (para 10-16b)
12. a (para 10-17a)
13. a (para 10-22b)
14. c (para 10-22b)
15. d (para 10-16b)
16. b (para l0-22a)
17. a (para 10-16f)

End of Lesson 10

LESSON ASSIGNMENT

LESSON 11 Oxytocics and Ergot Alkaloids.

LESSON ASSIGNMENT Paragraphs 11-1 through 11-13.

LESSON OBJECTIVES After completing this lesson, you should be able to:

11-1. Given a group of statements, select the statement that describes the role of oxytocin in the birth process.

11-2. Given a group of statements and the name of one of the stages of labor, select the statement that describes that stage.

11-3. From a list of uses, select the use(s) of oxytocin.

11-4. Given the trade and/or generic name of an oxytocic agent and a group of uses, side effects, or cautions and warnings, select the use(s), side effect(s), or caution(s) and warning(s) associated with the given agent.

11-5. From a list of uses, select the use(s) of ergot alkaloids.

11-6. From a group of statements, select the statement that describes ergotism.

11-7. Given the trade and/or generic name of an ergot agent and a list of uses, side effects, cautions and warnings, or patient information statements, select the use(s), side effect(s), caution(s) and warning(s), or patient information statement(s) associated with the given drug.

11-8. From a list of conditions, select the condition(s) in which the use of ergot alkaloids and/or oxytocics is/are contraindicated.

11-9. Given the trade or generic name of an oxytocic or ergot alkaloid agent and a list of trade and/or generic names of medications, select the trade or generic name that corresponds to the given drug name.

SUGGESTION

After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 11

OXYTOCICS AND ERGOT ALKALOIDS

Section I. OXYTOCICS

11-1. INTRODUCTION

In previous lessons, the female reproductive system was discussed. Usually females have little difficulty delivering the offspring. In some instances, however, the physician may need to intervene in the birthing process. In these cases, the physician may choose to use an oxytocic to speed up the birth process.

11-2. THE PROCESS OF BIRTH

During gestation (the time the fetus is in the uterus), the uterus is relatively quiet in terms of muscle contraction. However, as the time draws near for the process of birth to begin, the uterus begins to contract. These forceful contractions are necessary for the fetus to be expelled from the uterus. Oxytocin is a hormone that causes the uterus to contract.

11-3. ACTION OF OXYTOCIN

Oxytocin directly stimulates contractions of the muscles of the uterus. In general, the gravid uterus is much more responsive to oxytocic action than is the nongravid uterus. In other words, the closer a woman is to giving birth to the child, the more responsive her uterus will be to the effects of oxytocin.

11-4. ROLE OF OXYTOCIN IN THE BIRTH PROCESS

Oxytocin is produced in the neurohypophysis. Oxytocin is a substance that causes the uterus to contract. Another hormone, relaxin, helps to relax some of the ligaments attached to the pubic area. Together, these hormones act to produce conditions favorable to the birth of the fetus. If it were not for the actions of relaxin, the forceful uterine contractions produced by oxytocin would harm the fetus and the mother. Oxytocin, therefore, serves to begin labor and to expel the afterbirth (placenta, etc.) after the delivery of the infant.

11-5. THE STAGES OF LABOR

To understand the role of oxytocics in the delivery of a baby, the three stages of labor must be understood (See figure 11-1). These stages and what happens in them are presented below:

a. **Stage I.** Stage I of labor is characterized by regular contractions of the uterus as well as other physical changes. The contractions become increasingly more intense as labor proceeds. Oxytocin, a hormone produced in the neurohypophysis, is usually released to cause the onset of uterine contractions.

b. **Stage II.** Stage II of labor is characterized by the actual delivery of the infant(s).

c. **Stage III.** Stage III of labor is characterized by the expulsion of the afterbirth (placenta, amniotic sac, and membranous tissue contained in the uterus).

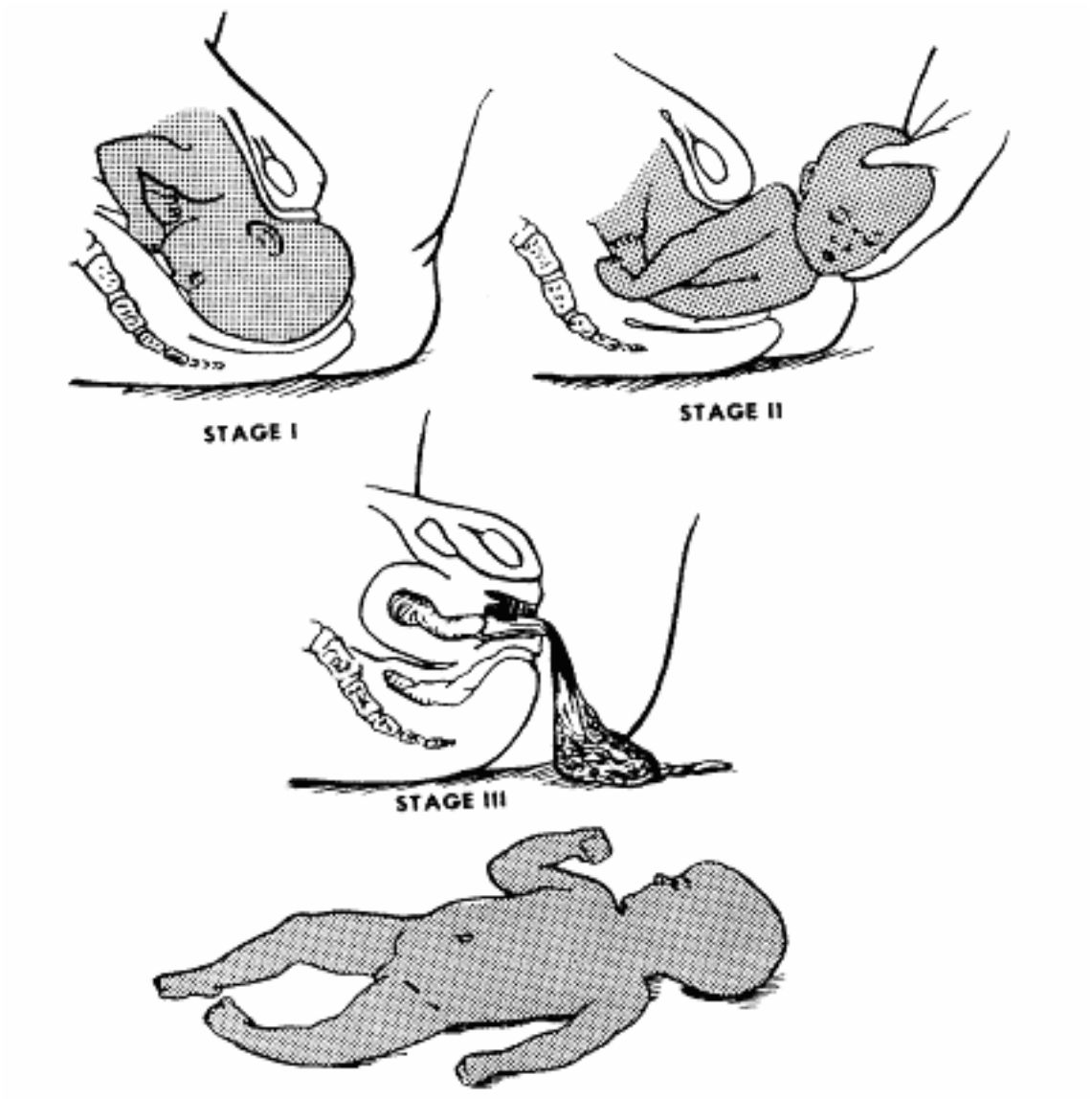


Figure 11-1. The stages of labor.

11-6. USES OF OXYTOCIN

Oxytocin has many uses in medicine. A few of these uses will be discussed here.

a. **Induce Labor at Term.** If the physician believes it is required, oxytocin may be administered intravenously to the pregnant woman at term in order to induce contractions of the uterus.

b. **Control Postpartum Hemorrhage.** Oxytocin can also be used to reduce uterine bleeding after the infant has been born. Remember, oxytocin causes contractions of the uterus.

c. **Relieve Postpartum Breast Engorgement.** Oxytocin is used to relieve postpartum breast engorgement in women who are going to breastfeed their infants in that it causes “milk let-down.” “Milk let-down” is a situation in which the milk in the breasts travels from alveoli to the nipples where it can be suckled by the infant. If the milk does not travel from the alveoli to the nipples, the breasts can become swollen and sore. In addition to relieving postpartum breast engorgement, oxytocin can also aid in milk ejection from the breasts by having the milk move toward the nipples.

d. **Prevent Uterine Atony.** After delivery, the uterus must return to its normal size and position. Oxytocin can help in this process by causing the uterine muscle to contract back to its original position. Thus, ocytocin can prevent uterine atony (i.e., when the uterus loses its proper muscle tone).

e. **Aid in Placental Transfer.** Placental expulsion can be aided by the administration of oxytocin.

11-7. NOTE CONCERNING USE OF MORE THAN ONE OXYTOCIC AGENT AT A TIME

The physician should never administer more than one oxytocic at any one time due to the synergistic effect produced. See MD0804, Pharmacology I, for a discussion of synergism.

11-8. UTERINE STIMULANTS

The following products are used as uterine stimulants.

a. **Oxytocin (Pitocin®, Synthocinon®).** Oxytocin can be used on either an inpatient or an outpatient basis. On an inpatient basis, the drug is used to induce labor and/or to aid in contro1ling postpartum hemorrhage. For these uses, the physician can use either the injection or the buccal tablet dosage form. The dosage of either dosage form is adjusted based on the uterine response of the patient. On an outpatient basis, oxytocin is used to aid in breast milk ejection. The physician uses the nasal spray

dosage form for this use. The usual dose of the nasal spray dosage form is one spray in each nostril two to three minutes before nursing. Side effects associated with the use of oxytocin include increased blood pressure, nausea and vomiting, and labored breathing.

b. **Ergonovine Maleate (Ergotrate®).** Ergonovine maleate is used to control postpartum hemorrhage. It is not used to induce labor. The dosage of this product is adjusted based on the uterine responses. Ergonovine maleate is supplied in both injection and tablet dosage forms. Side effects associated with this agent include increased blood pressure, nausea and vomiting, and labored breathing. Both the tablet and injection dosage forms are used on an inpatient basis; however, on rare occasions the tablets may be dispensed for outpatient use.

c. **Methylergonovine Maleate (Methergine®).** Methylergonovine maleate is used to control postpartum hemorrhage and to prevent uterine atony. It is supplied in both injection and tablet dosage forms. The usual dosage for the injection is 0.2 milligram every two to four hours as needed. The usual dosage for the tablet is one tablet three or four times daily for a maximum of one week during puerperium. (NOTE: Puerperium is the period of hospital confinement after a woman has given birth to the child.) The side effects associated with this agent include increased blood pressure, nausea, vomiting, and labored breathing.

Section II. ERGOT ALKALOIDS

11-9. INTRODUCTION

Ergot alkaloids are agents which are derivatives of Claviceps purpurea, the ergot fungus. This fungus naturally attacks wheat and rye. Some of the effects of ergot alkaloids were discovered when grain with the ergot fungus was ingested by people many years ago. Specifically, some persons who ate the contaminated grain developed gangrene due to the vasoconstriction caused by the ergot alkaloids. Furthermore, pregnant women who ate the contaminated grain aborted the fetuses because the ergot alkaloids produce effects similar to oxytocin (i.e., uterine contractions).

11-10. USES OF THE ERGOT ALKALOIDS

Ergot alkaloids are mainly used in the management of migraine headaches, but they can also be used to control postpartum hemorrhage.

11-11. ERGOTISM

The primary problem associated with ergot alkaloids is the possibility of the patient suffering from ergotism. Ergotism is an intoxication or poisoning due to an overdose of the ergot alkaloids. Ergotism is characterized by hot and cold sensations in the hands and feet (sometimes called St. Anthony's Fire), numbness, tingling,

vasoconstriction leading to gangrene, vomiting, and convulsions with a possible loss of consciousness and death.

11-12. SPECIFIC ERGOT AGENTS

The following ergot agents are commonly dispensed to patients.

a. **Ergotamine Tartrate (Gynergen®, Ergomar®).** Ergotamine tartrate is used in the management of migraine headaches. This product is available in both an injection and in a tablet dosage form. The usual dosage for injection is 0.5 to 1.0 milliliter given intramuscularly (IM). The usual dosage of the tablets is two to six tablets per attack given at one-half hour intervals. The main concern associated with ergot therapy is ergotism (see para 11-11). In order to prevent ergotism, the maximum dose for the injection is two milliliters per week, while the maximum dosage for the tablets is six tablets per day, 10 tablets per week, or 30 tablets per month. It is imperative that the patient be informed of the dosage restrictions for the tablet form. Ergomar® is available only in buccal tablet form. The usual dose of this product is one tablet administered buccally every 30 minutes as needed. The dosage is not to exceed three per day or five per week.

b. **Ergotamine Tartrate with Caffeine (Cafergot®).** Cafergot® is commonly used in the treatment of migraine headaches. It is useful in the management of migraine headaches because the caffeine enhances the effect of the ergotamine tartrate in constricting the blood vessels of the brain. The usual dosage is two tablets at the onset of a headache and one tablet every 30 minutes after until, if necessary, a maximum of six tablets are taken. If the patient is using the suppository form of the product, the usual dose is one suppository at the onset of a headache and another suppository after one hour, if necessary, until a maximum of two suppositories are inserted. Ergotism is seen in patients who take high doses of this medication. With the tablet dosage form, the maximum number of tablets to be taken per day is 6, per week is 10, and per month is 30. With the suppository dosage form, the maximum number per day is two and per week is five.

c. **Ergotamine Tartrate with Caffeine and Pentobarbital (Cafergot P-B®).** This product is used in the treatment of migraine headaches. The pentobarbital is added for its sedative effect. The product is supplied in both tablet and suppository dosage forms. The usual dose of the tablet form is two tablets at the onset of a migraine headache and one tablet every one-half hour. The maximum number of tablets which can be taken per day is 6, per week is 10, and per month is 30. The dosage of the suppository form is one suppository at the onset of a migraine headache and one suppository after one hour. The maximum number of suppositories is two per day and five per week. This preparation may cause drowsiness because of the sedative effect produced by pentobarbital. The patient should be cautioned not to drink alcohol while under the influence of this medication.

d. **Methysergide Maleate (Sansert®).** Methysergide maleate is used to prevent the occurrence of migraine headaches. Hence, this product is taken on a daily basis by the patient. This product is available in a 2.0 milligram tablet. The usual dosage of the product is 4 to 8 milligrams per day. Methysergide maleate can be used for persons who are not responsive to other types of ergot alkaloids. Furthermore, this drug is used by people who are disabled by their migraine headaches. Sansert® is usually taken with meals. Typically, a patient who takes this product is told by the physician not to take the medication for three to four weeks of every six months in order to allow the body to deplete some of the ergot alkaloids. This helps to prevent ergotism.

e. **Ergotamine Tartrate, Phenobarbital, and Belladonna Alkaloids (Bellergal®, Bellergal-S®).** This product is not typically used in the management of migraine headaches, although it is an ergot alkaloid preparation. Instead, it is used in the management of nervous disorders and disorders characterized by exaggerated autonomic response. Some menopausal, cardiovascular, gastrointestinal, and genitourinary disorders fall into these categories. Bellergal® is available in tablet form with the usual dosage being one tablet in the morning, one tablet at noon, and two tablets at bedtime. Bellergal-S®, an extended action tablet dosage form, has a usual dosage of one tablet in the morning and one tablet in the evening. Bellergal® and Bellergal-S® may cause drowsiness as a side effect. You should caution the patient receiving this medication that alcohol should not be consumed when taking this medication.

11-13. CONTRAINDICATIONS FOR OXYTOCICS AND ERGOT ALKALOID PRODUCTS

Both the oxytocics and the products containing ergot alkaloids produce vasoconstriction. Consequently, these categories of drugs are contraindicated in patients who have peripheral vascular disease (PVD), cardiac or pulmonary disease, impaired renal or hepatic function, hypertension, or are in the third trimester of pregnancy. The contraindication is especially true for ergot alkaloids taken by pregnant women in the management of migraine headaches.

Continue with Exercises

EXERCISES, LESSON 11

INSTRUCTIONS: The following exercises are to be answered by marking the lettered response that best answers the question or best completes the incomplete statement or by writing the answer in the space provided.

After you have completed all the exercises, turn to “Solutions to Exercises” at the end of the lesson and check your answers.

1. Which of the following statements describes the role of oxytocin in the birth process?

   a. Oxytocin causes the uterus to contract in order to expel the fetus.

   b. Oxytocin causes some of the ligaments attached to the pubic area to relax in order that the baby can be expelled from the uterus without injury.

   c. Oxytocin causes the uterus to undergo atony in order to protect the fetus during the birth process.

   d. Oxytocin causes the uterine muscles to relax during the birth process in order that the fetus can move from the uterus without injury.

2. Which of the following are uses of oxytocin?

   a. Control postpartum hemorrhage and prevent milk ejection.

   b. Prevent uterine atony and prevent placental expulsion.

   c. Induce uterine atony and relieve postpartum breast engorgement.

   d. Prevent uterine atony and induce labor at term.

3. Ergonovine maleate is used to:

   a. Treat hypertension.

   b. Control postpartum hemorrhage.

   c. Prevent morning sickness.

   d. Prevent uterine atony.

4. Ergot alkaloids are used to:

    a. Treat gangrene and to prevent vasoconstriction.

    b. To manage migraine headaches and to induce uterine contractions.

    c. Control postpartum hemorrhage and to manage migraine headaches.

    d. Treat St. Anthony's Fire and to prevent uterine atony.

5. Ergotism is described as:

    a. A serious condition caused by ergot alkaloids in which the patient experiences numbness due to intense vasodilation.

    b. An intoxication due to overdose of the ergot alkaloids which is characterized by hot and cold sensations in the hands and feet.

    c. A problem associated with the therapeutic use of ergot alkaloids in which the patient experiences hot and cold sensations in the lower abdomen.

    d. A condition characterized by hot and cold sensations in the hands and feet which is caused by oxytocin intoxication.

6. Ergomar® is used in the:

    a. Treatment of insomnia.

    b. Treatment of alcoholism.

    c. Management of migraine headaches.

    d. Inducement of labor.

7. One side effect associated with the use of Cafergot® is:

    a. Ergotism (with high doses).

    b. Drowsiness.

    c. Hypertension.

    d. Postpartum breast engorgement.

8. Both oxytocics and ergot alkaloid products are contraindicated in patients who have:

   a. Hypotension.

   b. Migraine headaches.

   c. Diabetes mellitus.

   d. Peripheral vascular disease (PVD).

SPECIAL INSTRUCTIONS FOR EXERCISES 9 THROUGH 12. In exercises 9 through 12, match the generic name listed in Column A with its corresponding trade name in Column B.

Column A	Column B
9. ___ Ergotamine tartrate with caffeine	a. Cafergot®
10. ___ Methylergonovine maleate	b. Sansert®
11. ___ Methysergide maleate	c. Ergotrate®
12. ___ Ergonovine maleate	d. Methergine®

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 11

1. a (para 11-4)
2. d (para 11-6)
3. b (para 11-8b)
4. c (para 11-10)
5. b (para 11-11)
6. c (para 11-12a)
7. a (para 11-12b)
8. d (para 11-13)
9. a (para 11-12b)
10. d (para 11-8c)
11. b (para 11-12d)
12. c (para 11-8b)

End of Lesson 11